ENVIRONMENTAL ANALYSIS

Confidential Claim Retracted

Authorized by: SL

Date: 6/12/13

Proposed
P-15/17
Underground Mine
Jackpile-Paguate Minesite
The Anaconda Company

Laguna Tribal Lease 4
Laguna Indian Reservation
Valencia County, New Mexico

U. S. Geological Survey
Conservation Division
P. O. Box 26124
Albuquerque, New Mexico

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I. Description of the Proposed Action

A. Introduction

The Anaconda Company, New Mexico Operations, Uranium Division, originally submitted the proposed action to the Geological Survey (USGS) March 18, 1976, under the provisions of Title 25, Code of Federal Regulations, Part 177.7. At that time, the proposal consisted of a mining and reclamation plan for two separate underground uranium mines developed through two vertical shafts. The mines would have been known as the P-15 and P-17 Mines.

August 15, 1977, The Anaconda Company formally submitted modifications of the original mining plan to the Geological Survey. These modifications provide for development of both the P-15 and P-17 ore deposits through a single adit entry instead of the two separate shafts originally proposed. The adit portal and mine workings, the P-15/17 Underground Mine, would be located within the boundaries of Laguna Tribal Uranium Mining Lease 4 which occupies approximately 2,560 acres of the Laguna Indian Reservation in Valencia County, New Mexico (Maps A and B).

Laguna Lease 4 contains the lands listed below:

Township 10 North, Range 5 West, N.M.P.M.:

Sec. 3, S½S½NW¼, SW¼	(200 acres)
Sec. 4, S½S½N½, S½	(400 acres)
Sec. 5, SE¼NW¼, Lots 1 & 2, S½NE¼, E½SW¼, SE¼	(439.79 acres)
Sec. 8, NE¼NW¼, N½N½SE¼NW¼, NE¼, NE¼SE¼, E½W½SE¼SE¼, E½SE¼SE¼	(280 acres)
Sec. 9, All	(640 acres)
Sec. 10, NW¼, N½SW¼, N½S½SW¼	(280 acres)
Sec. 16, N½	(320 acres)

The P-15 ore bodies are located within Section 9 of the lease and contain an estimated 517,644 tons of uranium ore. The P-17 deposits contain approximately 594,666 tons of ore in Sections 9 and 16 (Map B). The small Indian villages of Paguate and Laguna are located about 2 miles to the north and 5 miles to the south, respectively (Map A).

The Anaconda Company acquired Lease 4 through negotiations with the Pueblo of Laguna, and it became effective July 30, 1963, for a term of 10 years "and as long thereafter as the minerals specified are produced in paying quantities." The original lease contained about 9,100 acres, but subsequent relinquishments have lowered the present acreage to 2,559.79.

Anaconda also holds Laguna Tribal Uranium Mining Lease 1 which is the site of the company's large Jackpile-Paguate open-pit mining operations that have produced uranium ore since 1952. Lease 1 occupies 4,988.48 acres immediately adjacent to Lease 4 to the northeast and was also negotiated with the Pueblo of Laguna, becoming effective May 7, 1952, for a term of 10 years "and as long thereafter as the minerals specified are produced in paying quantities."

The surface and mineral rights within Leases 1 and 4 are owned entirely by the Pueblo of Laguna. An agreement effective June 10, 1974, unitized all of Anaconda's Laguna leases so that "exploration, development and production on any one or more of such leases shall be deemed to satisfy any and all exploration, development and production requirements on all leases between the parties."

The proposed action was submitted March 19, 1976, to the Southern Pueblos Agency of the Bureau of Indian Affairs (BIA) and the Pueblo of Laguna for their review, recommendations and approval. An environmental analysis (EA) of the original proposal was prepared and was submitted to the above parties

August 13, 1976, for their review. A meeting between the USGS, BIA, Pueblo of Laguna Technical Committee and Anaconda was held July 8, 1977, to discuss the proposed action, the EA and the modifications of the proposal which were to be submitted in the near future. At this meeting, it was decided to revise the EA to include the modifications of the proposal instead of approving the plan as originally submitted with later processing of the modifications (Appendix XI).

August 15, 1977, The Anaconda Company formally submitted the modifications of the proposed action which were forwarded to the BIA and Pueblo of Laguna August 17, 1977. This EA is a revised version of the original analysis and has been reviewed by the involved parties. Appendix X contains the BIA's and Pueblo of Laguna's comments and recommendations regarding the proposed action as modified.

Any actions by other State and/or Federal agencies or authorities would concern approval of, or issuance of permits for, such things as waste water discharge and/or impoundment, sewage treatment, etc. Anaconda is in the process of obtaining, or will obtain, such approvals and/or permits as necessary before commencing operations. Prescribed public postings of the proposed action have resulted in no inquiries, comments or evidence of controversy.

B. Proposed Mining Procedure and Facilities

The P-15/17 underground workings would be located adjacent to the southernmost end of the producing P-10 Mine and would extend southward for approximately 8,100 feet (Map B). Access to the workings would be provided by a double-track adit with a finished cross-section of 10 by 14 feet or by two smaller parallel adits with comparable capacity.

The adit portal would be located in North Oak Canyon, and the adit would be driven on a southwest bearing under Black Mesa at an average positive grade of 1 percent for a total completed distance of 4,640 feet. (See 200-scale topographic map in mining plan modifications.) This entry would serve as the haulageway for transporting ore and waste material to the surface as well as providing access for personnel and supplies. The adit would also carry air to the mine workings for proper ventilation. A private contractor would be engaged to drive the adit, cut the service stations and do part of the subsequent drift and raise development.

Mining of the P-15/17 ore bodies would be done by conventional modified room-and-pillar stoping methods with sublevel track haulage. Raises would be driven from the haulage level into the overlying ore lenses, and the ore would then be developed by small access drifts driven through and around the mineralized areas. Stoping would take place next with internal waste pillars left in place for support. Additional ground support would be provided by rock bolts, steel sets, timber sets, stulls, and/or cribbing. When two or more ore bodies are stacked, development and stoping would take place from the uppermost to the lowest ore body in descending order. (See inspection reports in Appendix XI.)

In addition to the adit entry, 22 ventilation boreholes equipped with surface fans would be needed during the life of the operation for proper ventilation of the mine. These boreholes would be drilled from the surface with 48-inch diameters and then cased with 42-inch inside diameter casing cemented in place (Photo B). The depths of the holes would range from 432 to 650 feet. Axial flow vane-type fans ranging from 25 to 100 horsepower would be used on the vent holes, and each hole would most likely be equipped with a heater to prevent freezing (Photos C and D). Each vent shaft would be capable of handling about 40,000 cubic feet of air per minute (CFM). The disturbed areas around the vent holes would be graded and seeded after installation of the ventilation equipment.

About 200,000 to 268,000 CFM would be required by the mine during full production. The vent holes have been tentatively located (see 200-scale topographic map in mining plan modifications) so that the haulage drifts would normally be under positive pressure and the stopes under negative pressure, but their exact locations and order of completion would be determined as mine development proceeded. Furthermore, not all of the vent holes would necessarily be equipped with fans at any given time, particularly during the later years of the mine's life. As mining proceeded and the workings advanced beyond the effective usefulness of the vent holes, they would be abandoned as others were drilled. The upcast or downcast nature of each vent hole would also depend on mining progress. The vent shafts at the extremities of the mine would be upcast, but as mining proceeded beyond the usefulness of these shafts, new upcast vent holes would be drilled and the former shafts reduced in capacity or abandoned.

Vent hole #6 which would be located at the southwestern end of the adit would be equipped with a small hoist and torpedo-type cage to provide a second independent exist from the mine (Photo E). This would satisfy State mining regulations and permit more than 10 men to be underground at one time. In addition, a mobile crane with sufficient hoisting capacity and cable would be available for use at any vent shaft as an emergency hoisting unit.

Surface drilling indicates that the P-15/17 ore bodies contain an estimated 1,112,310 tons of uranium ore. According to the plan, driving of the adit would commence in 1977 with ore production beginning in January 1979. 1984? The life of the mine would be about 5 years, and about 200 persons would be employed during the period of maximum production of about 950 tons of ore per day (TPD).

Vehicular access to the mine would be provided by a road about 30 feet wide off the south rim of North Oak Canyon. (See general surface layout drawing in mine plan modifications.) This road would be for light vehicular traffic only and would be about 2,200 feet long for a total area of about 1.5 acres. Another road about 60 feet wide would exit over the north rim of the Canyon to connect with the present system of open-pit roads. It would have a total mine-to-stockpile area length of about 7,900 feet, of which approximately 4,300 feet would be a new road, for a total area of about 11 acres.

The proposed road locations have been planned to avoid as much excess cut and fill as possible. Both roads would be surfaced with waste rock material from the mining operations, and culverts would be used where the roads crossed major drainage channels. Both roads would occupy a total area of about 12.5 acres.

The mine yard would consist of two working areas. (See general surface layout drawing in mine plan modifications.) The portal yard would contain facilities for transferring ore and waste rock from the underground railroad cars to surface trucks and would occupy about 2 acres. The service yard would occupy approximately 8 acres and would contain the surface buildings and supplies. The main buildings to be erected within the service yard would be a combination office-change house (about 50 by 125 feet), a compressor building (about 30 feet square), and a shop (about 40 by 100 feet). The surface facilities for the P-15/17 operations would probably be very similar to those for the P-10 Mine which are shown in Photos F and G.

Approximately 120,000 cubic yards of fill material would be required to level the portal and service yards. Waste rock from adit development would be the primary source of this material. Prior to site preparation, any topsoil in these areas would be removed and stored for use in reclaiming the disturbed areas at the cessation of the mining operations.

Two surface settling ponds, each measuring about 10 feet deep by 15 feet wide by 30 feet long, would be constructed in the adit portal area (shown as sump-2 cell on general surface layout drawing in mine plan modifications). These ponds would have a total capacity of about 67,000 gallons and would be lined with impervious clay, plastic or concrete. Ground water seeping into the mine workings would be collected in underground settling sumps at the terminal end of the adit and then pumped to the surface ponds which would also receive runoff from the ore transfer area. The surface ponds would be continually pumped with the water being carried via pipeline to the present P-10 pipeline which discharges into holding ponds in the mined out open-pit workings.

The particulate matter in the mine water would settle and collect in the ponds' bottoms. This sediment would be periodically removed and transferred to waste or ore stockpiles depending on its uranium content. The ponds would be equipped with a bypass system to allow continuous operation of one pond while the other is being cleaned and/or repaired, and the ponds' pumping systems would have auxiliary pumps and electrical power.

Although it is not possible to accurately predict or estimate the actual water flow into the mine workings, it is anticipated that the inflow would be quite small. The ore bodies are located in strata that are up dip from presently operating mines, and these strata are naturally drained by surrounding ravines and canyons. The operating P-10 Mine which is approximately 0.5 miles down the regional dip from the proposed P-15/17 Mine is currently pumping about 183 GPM.

One sewage lagoon about 150 feet wide by 450 feet long would be constructed south of the service yard. The lagoon would occupy about 1.5 acres and would be of sufficient capacity to dispose of all organic wastes from the mining facilities. In addition, the lagoon would comply with State standards and regulations, and a plan for its construction would be submitted to the New Mexico Environmental Improvement Agency (EIA) for approval.

Anaconda would control surface water runoff in all areas that would be disturbed by the P-15/17 operations in order to minimize or prevent erosion. The access and haulage roads would be constructed with berms, ditches, water bars and turnouts to control runoff. The mine yard and surface facilities would have ditches and berms for protection and to prevent concentrations of runoff that could cause erosion. The sewage lagoon would be isolated downhill from the mine yard and would be protected by ditches and berms on the perimeter to divert runoff. The disturbed areas around the vent holes would be graded and seeded after installation of the necessary equipment.

Potable water for the mine's surface facilities would be provided from the present Shop well (Map B and topographic map and general surface layout drawing in mining plan modifications). Water for the underground mine workings would be supplied by a supplemental well located on the surface near the underground terminus of the adit. This well would be completed either in sandstone units of the Brushy Basin Member or in the Westwater Canyon Member, both of the Jurassic Morrison Formation, depending on the quantity and quality of the water from the producing sands. The mine and support facilities would require an estimated 50 to 100 gallons of water per minute total.

Approximately 21,600 feet of surface power lines would be required to bring electricity to the P-15/17 facilities and ventilation boreholes. Erection of the lines would cause virtually no surface disturbance except for the very small areas required to set the power poles in the ground. Existing roads would be used for access during construction of the lines, and the power cables would be pulled through and installed manually. The lines and poles? would be removed at the end of mining operations.

Boring of the 22 ventilation shafts would require about 4.2 acres. Each site would be a minimum of 50 feet by 150 feet in order to set up the drill rig and supporting equipment (Photo B). The existing network of roads on Black Mesa would provide access to most of the sites.

Throughout the life of the mine, the mine yard, vent shaft areas, sewage lagoon, and the settling ponds would be fenced.

Explosives to be used in the P-15/17 operations would be stored at the surface in the existing explosives storage facility for the P-10 Mine. Underground magazines would be used to store explosives intended for immediate use in the mine workings.

C. Ore Processing

The ore from the mine workings would be trammed by underground ore trains through the adit to the surface where it would be selectively dumped according to grade into a transfer area in the portal yard. Only one or two days' production (maximum) would be stored in the transfer area at one time because it is anticipated that the ore would be transferred daily to the existing P-10 stockpile area about 1 mile east of the P-10 Mine. From this stockpile area, the ore would be periodically trucked to the existing railhead south of the Jackpile Pit where it would be crushed, weighed and loaded into railroad cars. The railroad cars would then be transported by the Atchison, Topeka and Santa Fe Railway (ATSF) over existing routes to the Company's operating Bluewater Mill about 50 miles to the west near Grants, New Mexico.

At the present time, the Bluewater Mill has the capacity to process about 3,500 TPD of ore. An acid-leach hydrometallurgical process is used to recover and concentrate the ore's natural uranium into a dried precipitate known commonly as yellow cake (U_3O_8). However, the milling facility is currently being expanded and modified to increase its capacity to approximately 6,000 TPD and to allow treatment of lower grade ores. Appendix XI contains an inspection report on the Bluewater Mill.

The ore from the P-15/17 mining operations would be feed material for the Bluewater Mill with the resultant yellow cake being sold to a utility company for further processing and ultimate use in nuclear powered electric generating plants. It would be possible, however, that the P-15/17 ore would be toll milled at Kerr-McGee Corporation's mill in Ambrosia Lake or at Sohio's milling facility just north of Anaconda's Laguna leases. Anaconda presently has most of its underground ore toll milled at Kerr-McGee's facility due to the ore's moisture content while a small amount of its open-pit ore is toll milled at Sohio's mill.

D. Reclamation

Upon cessation of the mining operations, all of the mine openings (adit portal or portals and ventilation shafts) would be sealed in accordance with the standards and regulations applicable at that time. Reclamation of the disturbed land surface would then commence, and it is anticipated that the reclamation operations would be completed in approximately 2 months.

The permanent structures erected in the service yard would remain intact according to Agreement 3 of the mining lease. Mining equipment and other personal property would be removed from the mine site and vent shaft areas to be used at other Anaconda operations or sold.

Reclamation of the disturbed land surface at the ventilation shaft sites would occur after installation of the ventilation and associated equipment and fencing. The procedure would probably consist primarily of grading, scarifying, liming if necessary, and seeding the disturbed area. Final reclamation of the sites, after removal of the equipment and sealing of the shafts, would depend on the shaft sealing procedures utilized, but would probably also consist of grading, scarifying, liming and seeding.

The haulage and access roads would also be graded, scarified, limed if necessary, and then seeded. The portal and service yard areas, excluding the surface occupied by permanent structures, would first be graded and then covered with any topsoil removed and stockpiled prior to the mining operations. Necessary liming or fertilization would follow with subsequent seeding of the areas.

Water remaining in the settling ponds would either be allowed to evaporate or would be pumped to the P-10 holding pond. Sediments remaining in the ponds' bottoms would be removed and transferred to waste or ore stockpiles depending on the uranium content of the material. The ponds would then be backfilled, graded and seeded. Water in the sewage lagoon would be allowed to evaporate with subsequent backfilling, grading and seeding of the lagoon.

Reclamation of the P-15/17 mine area and ventilation shaft sites would probably coincide with the reclamation of various other mining areas in the immediate vicinity. In its comprehensive mining plan, Anaconda details the reclamation of the entire Jackpile-Paguate mining operation. Appendix XIII contains some of the reclamation information regarding equipment, techniques and seed varieties given in the comprehensive plan.

E. Related Actions

Several proposed actions involving uranium mining on Indian lands in New Mexico are presently pending before the Conservation Division of the USGS. The majority of these actions are located about 60 miles northwest of the Jackpile-Paguate minesite on Navajo Tribal and Allotted leases in the Crownpoint area of McKinley County, New Mexico. Continental Oil Company, Pioneer Nuclear Inc., and United Nuclear Corporation have submitted mining plans for underground uranium mines in this area, and environmental analyses of these plans are currently in progress.

Three other proposed actions involving uranium mining on Pueblo of Laguna lands are also pending before the Conservation Division. July 15, 1976, Continental Oil Company submitted a mining and reclamation plan for a large underground mine on Laguna uranium mining leases UL-1837 and -1838. These leases are situated within the Bernabe M. Montano Land Grant in Bernalillo and Sandoval Counties, about 25 miles northeast of the Jackpile-Paguate minesite. An EA of the plan has been prepared, and the Pueblo of Laguna has approved the plan.

January 5, 1977, The Anaconda Company submitted a mining and reclamation plan for the PW2,3 Mine Project. This plan provides for the development of several small ore bodies through an adit collared in a mined out portion of the North Paguate Pit. The ore bodies are located on the fringes of more concentrated ore zones that were mined by open-pit methods. An EA of the plan has been prepared and is presently being reviewed by the Pueblo of Laguna and the BIA.

February 5, 1977, Anaconda submitted a comprehensive mining and reclamation plan covering all of its Jackpile-Paguate open-pit and underground mining operations from the present time until the estimated completion of conventional operations in 1985. This plan includes the P-15/17 and PW2,3 proposals, and an EA of the plan is being prepared.

II. Environmental Considerations of the Proposed Action

A. Geology

1. Physiography

The Anaconda Company's Jackpile-Paguate Minesite lies almost in the center of the Laguna Uranium Mining District which is an area of about 535 square miles on the east side of the Colorado Plateaus physiographic province (Map C) (Moench and Schlee, 1967, p. 3). Structurally, this area is in the southeastern part of the San Juan Basin, a broad topographic depression characterized by broad open valleys and mesas and local deeply incised drainage features. The Mount Taylor volcanic field is located to the north and west of the area (Dinwiddie, 1963, p. 217).

The Laguna District is located in mesa country that is typical of much of the Colorado Plateaus province. Mesa Chivato, the largest and highest mesa, rises to an altitude of 8,000 feet above sea level on the northwest side of the district with its flat lava top covering about 400 square miles. Mesa Gigante rises to an altitude of more than 6,500 feet on the southeastern side, and the similar but much smaller Mesa Prieta is located on the northeastern side about 14 miles east of Mesa Chivato (Map A). Between these prominent landmarks are smaller mesas and benches. The northeastern part of the district is characterized by low mesa and bench topography, and in this area as well as farther south, the land surface is pierced by several volcanic necks that rise abruptly to as much as 1,000 feet above the surrounding landscape (Moench and Schlee, 1967, pp. 3-4). From the southern part of Mesa Chivato, the roughly conical Mount Taylor, a large inactive volcano, rises more than 11,300 feet above sea level and more than 5,000 feet above the valley of the Rio San Jose to the south (Hunt, 1936, p. 36).

The perennial Rio San Jose is the main drainage in the Laguna District. It drops from an elevation of about 5,900 to less than 5,600 feet from west to east, and it is entrenched 20 feet or more over most of its length. A few miles southeast of the district, it joins the Rio Puerco, a tributary of the Rio Grande (Moench and Schlee, 1967, p. 4) which flows continuously only during the wet season. The Rio Puerco drains the west flank of the Nacimiento Mountains forming the east boundary of the district (Hunt, 1937, p. 37).

Several arroyos join the Rio San Jose from the north and south, but ordinarily most of them flow only after summer thunderstorms. The largest of these arroyos are the perennial Rio Paguate and the intermittent Arroyo Conchas which drain the area to the north of the Rio San Jose and the Arroyo Colorado which drains the broad valley to the south. The Arroyo Salado drains the northeast corner of the district and joins the Rio Puerco to the east (Moench and Schlee, 1967, p. 4). All the main streams and tributaries are entrenched into arroyos cut in the alluvial fill of the valleys. These arroyos carry very large quantities of water immediately after heavy precipitation, and occassionally the waters rise over the banks and spread out as sheet floods (Hunt, 1937, p. 37).

The proposed mine would be located under

Black Rim Mesa (Maps B and D) where elevations range from about 6900 to 6000 feet above sea level (Photos I, J, K). The surface is cut by several northeast trending dry washes that channel surface runoff toward the Rio Paguate.

2. Stratigraphy

The San Juan Basin is characterized by a sedimentary fill of marine and continental rocks several thousand feet thick and from Paleozoic to Quaternary in age. These sedimentary beds dip gently from the basin margins toward the center, and intrusive igneous rocks of Tertiary and Quaternary ages occur locally around the basin margins. The southern part of the Colorado Plateaus province, the Datil volcanic field (Map C), is characterized by an extensive covering of lavas and associated continental sedimentary rocks that total several thousands of feet in thickness (Hilpert, 1969, p. 9). Table I in Appendix II shows the regional stratigraphy as modified from Hilpert's compilation (1969) with the representative thicknesses of the stratigraphic units (NMEI, 1975, p. 159).

The Jackpile-Paguate Mine area is located in the southeastern part of the San Juan Basin, east of the Mount Taylor volcanic field. Rocks ranging in age from Late Triassic to Recent crop out in or near the area, and the regional dip of the beds is northward to northwestward at about 2 degrees. Minor faults and folds vary the dips locally (Dinwiddie, 1963, p. 217). Columns 2 and 3 in Appendix II show the stratigraphy in the areas of the P-15 and P-17/ore bodies respectively according to The Anaconda Company.

The primary host for uranium deposits in northwestern New Mexico is the Morrison Formation of Late Jurassic age. The Morrison is 400 to 800 feet thick and generally consists of mudstone (gray, maroon, buff), vari-colored claystone, and medium-to coarse-grained sandstone (gray to reddish-brown). The sandstone is arkosic and locally conglomeratic and locally contains concentrations of carbonaceous materials. The Salt Wash, Recapture, Westwater Canyon, and the Brushy Basin Members make up the Morrison Formation from base to top, but the Salt Wash Member occurs only in northwestern San Juan County (Hilpert, 1969, p. 19).

In the Laguna District, the Morrison Formation is composed mostly of a relatively thick Brushy Basin Member and markedly thinner Westwater Canyon and Recapture Members. It attains its maximum thickness of about 600 feet in the central part of the district from where it thins laterally. Southward it is beveled under the pre-Dakota erosion surface, and it is absent in the southern part of the district (Hilpert, 1969, p. 71-72).

The Recapture Member in the district ranges from 0 to about 100 feet in thickness with a probable average of about 25 feet. It is composed of alternating grayish-red and greenish-gray mudstone, siltstone, sandstone, and a few thin beds of limestone. The overlying Westwater Canyon Member ranges in thickness from 0 to more than 100 feet with an average of about 50 feet. It is thickest in the northern part of the district from where it thins southward, and locally it grades into the Recapture. It consists of grayish-yellow to very pale orange, fine-to-coarse-grained, friable sandstone (Hilpert, 1969, p. 71-72).

The Brushy Basin Member overlies the Westwater Canyon and makes up most of the Morrison Formation. From the central part of the district where it is more than 300 feet thick, it thins laterally most markedly southward and is cut out in the southern part of the district under the pre-Dakota erosion surface. It is composed of grayish-green bentonitic mudstone and some sparse thin beds of clay-rich sandstone. In the lower part it contains sandstone lenses similar to the Westwater Canyon which are generally less than 20 feet thick but locally as much as 85 feet thick. In the central part of the district, the Brushy Basin contains, in its upper part, the Jackpile sandstone which is the main ore-bearing unit (Hilpert, 1969, p. 71-72).

The Jackpile sandstone contains nearly all the known deposits in the Brushy Basin Member, and all the principal deposits in the Morrison Formation, in the district. It is a tabular body about 15 miles wide by 35 miles long extending from the vicinity of Laguna to the vicinity of Mesa Prieta. It has a maximum thickness of about 200 feet a few miles north of Laguna from where it tapers to its margins and, to the northeast, splits into two fingers. The Jackpile consists of a yellowish-gray to white, friable, fine-to medium-grained, fluvial sandstone that generally grades from coarser-grained subarkosic material at the base to finer material at the top (Hilpert, 1969, p. 71-72).

3. Structure

The Laguna District is located mainly on the east limb of the McCarty's syncline which dips gently northwestward into the San Juan Basin (Map E). On the east side of the district the beds are downdropped along the north-trending, faulted Ignacio Monocline into the Rio Grande trough, and the volcanic rocks of Mount Taylor cover the western side of the district. Numerous volcanic centers, flows, dikes, and sills are located throughout the district and mark the northern part of the Datil volcanic field (Hilpert, 1969, p. 72).

Three periods of tectonic activity are generally recognized. Jurassic deformation resulted in two sets of low amplitude folds, one trending east to northeast and one trending north-northwest. This folding was accompanied by slumping and internal faulting of unconsolidated clastic sediments and by the formation of peculiar cylindrical subsidence structures or sandstone pipes. The folding also influenced sedimentation. Late Cretaceous to middle Tertiary deformation caused the tilting of the beds to the northwest.

The third period of activity occurred from middle to late Tertiary time and possibly extended into Quaternary time. This period marked the subsidence and sedimentation of the Rio Grande trough and produced the north-trending normal faults, the faulted monocline along the west border of the trough, and the joints in the sedimentary rocks. The fracturing was accompanied by the emplacement of numerous dikes and sills.(Hilpert, 1969, p. 72).

There are no recognizable geologic structures in the proposed mining area. The regional dip of all the involved sediments, Jurassic and Cretaceous, is very shallow, about 2 degrees to the northwest. A small vertical diabase sill which has a maximum thickness of 2 feet and a north-northeast trend has been mapped and may extend into the area, but the extensive colluvium cover in the area (up to 100 feet thick) effectively hides most features. Generally, there is very little geological disturbance in the area (The Anaconda Company, 1976).

4. Nature of Deposit

In the Laguna District, the largest uranium deposits are in the Jackpile sandstone unit of the Brushy Basin Member. The deposits may be composed of one or more semitabular ore layers that range from almost equidimensional to strongly elongate in plan view. The layers are figuratively suspended within the host sandstone (Moench, 1963, p. 159), and they range in thickness from only a few inches to as much as 20 feet and occur in multiple units that are as much as 50 feet thick. The deposits' lateral dimensions range from a few feet to several thousand feet (Hilpert, 1969, p.74). The principal ore minerals of the relatively unoxidized parts of deposits are coffinite and uraninite which are intimately mixed with carbonaceous matter (Moench, 1963, p. 159).

The P-15 ore deposits are vertically distributed from the base to the top of the Jackpile sandstone at depths ranging from 470 to 650 feet. They range from 3,000 to 3,600 feet in length, from 400 to 1,400 feet in width, and from about 6 to 65 feet in thickness. The ore has an average thickness of about 15 feet. In areas where the ore bodies are stacked, the separation between them ranges from 10 to 38 feet with an approximate average of 20 feet. The P-15 ore bodies contain 517,644 tons of ore with an average grade of 0.23% U_3O_8(The Anaconda Company, 1976).

The P-17 ore deposits, however, are located in the upper two-thirds of the Jackpile sandstone at depths of about 260 to 590 feet. Here the ore bodies vary from 4,000 to 5,000 feet in length, from 200 to 1,600 feet in width, and from 6 to 35 feet in thickness. Average thickness of the ore is about 10 feet. Stacked ore bodies are separated from 10 to 33 feet with an average separation of about 20 feet. The P-17 ore bodies contain 594,666 tons of ore with an average grade of 0.23% U_3O_8 (The Anaconda Company, 1976).

5. Geologic Hazards

There are no known potentially serious geological hazards in the proposed mine area. The colluvium in the area appears to be well stabilized with no evidence of any recent significant slippage (The Anaconda Company, 1976).

Based on available data, the seismic risk for the project area seems low. An earthquake with a magnitude of 5 is possible in the Grants area about 30 airline miles to the west, but it would probably have a negligible effect on the project area (NMEI, 1975, p.174) (See Figure 1 and Tables 1 and 2 in Appendix III). The Rio Grande rift, a prominent chain of structural depressions that extends southward from south-central Colorado through New Mexico, is about 35 miles minimum southeast of the proposed project area. Investigations have concluded that the portion of this structure extending from Albuquerque to Socorro has the highest seismic risk, and it is estimated that the largest shock along this structure in a 100 year period would have a magnitude of 6. A magnitude 6 shock at a distance of 35 miles would probably not have a significant effect on the project area (NMEI, 1974, p.91)(See Figure 2 and Tables 3 and 4 in Appendix III).

Subsidence of the strata overlying the underground mine workings would not be excessive, if any at all, depending on certain combinations of ore depth and thickness, mining extraction, and strength of the overlying strata. After the extraction of smaller deposits in most uranium mines in the districts, caving over the mined out areas stops when the increased volume of the caved rock fills the void. In addition, caving of the less competent sandstone frequently ceases upon reaching a stronger layer of indurated shale within a vertical distance of less than 30 feet.

It would be possible, however, that over the thicker ore bodies or over stacked ore bodies with minimum vertical separation, the subsidence of overlying strata could be significant enough to result in some surface expression. This would probably be only a gentle depression in the surface over the underground workings, and it would not be considered necessary to have the company establish and monitor survey grid systems over the mine workings in order to detect surface subsidence during pillar removal.

The closest permanent structure that could possibly be affected by surface subsidence is State Highway 279 which would pass over the adit entry near the portal. Anaconda has agreed to establish and maintain a subsidence monitoring survey system in this sensitive area and to report the results of the surveys to the Area Mining Supervisor on a quarterly basis. See Part 2. Stipulations, Number 10. Subsidence Surveys in the Description of Request for Changes in Mining Plan.

6. Other Mineral and Non-Mineral Resources

There are no other known mineral or non-mineral resources in the proposed mining area (The Anaconda Company, 1976).

7. Soils

The main soil type in the proposed mining area is probably a shallow, fine textured, slowly premeable, and moderately eroded soil that is developed from basic igneous (basalt) rock. It occurs on moderately steep to steep slopes (12-55%)(The Anaconda Company, 1976). See Appendix IV for a description of the soils in the area.

B. Atmosphere

1. Meteorology

The climate of most of the Laguna District is semiarid. During the summers, the days are generally hot, but the dry atmosphere and almost continual breeze prevent the high temperatures from being unpleasant. The summer nights are invariably cool. The winters are moderately cold with freezing temperatures prevailing during the winter nights. Generally, the winter days are comparatively warm and pleasant (Hunt, 1937, p.37). Day-night temperature differences are much greater in New Mexico than they are in humid areas with most weather stations showing an average diurnal variation of from 30° to 40°F (NMEI, 1974, p.38). Mean annual temperatures for New Mexico stations decrease about 5°F for every 1000 feet of elevation increase (NMEI, 1974, p.40).

The mean yearly temperature for the Jackpile-Paguate area is about

$53^{\circ}F$ (Mudgett, P-10, 1975, p.5). Based on 26 years of records for San Fidel which is about 11 miles west of Laguna, freezing temperatures ($32^{\circ}F$ and below) do not occur during May to October (NMEI, 1974, p.40). In 1975, the maximum and minimum temperatures at Laguna were $95^{\circ}F$ and $-4^{\circ}F$ respectively (White, 1976, oral communication).

The annual precipitation in the Jackpile-Paguate area ranges from 4 to 18 inches (Mudgett, P-10, 1975, p.4) with an average of just under 10 inches (Gregg, 1976, oral communication) (See Figure 1, Appendix V). Showers usually occur in May with harder, downpour type rains in the middle summer months (July-August) and early fall being common (The Anaconda Company, 1973, p.8). A steep precipitation gradient exists in the area as Mount Taylor receives about 30 inches of annual rainfall (Gregg, 1976, oral communication). Table I in Appendix V shows the mean precipitation (inches) for stations in the Mount Taylor area.

Central New Mexico receives about 75% of the available winter sunshine and about 80% of the possible summer sunshine. The annual average for Albuquerque is 77%. Similar figures should apply to the proposed mining area, but the amount of sunshine is decreased on the slopes of Mount Taylor by cumulus cloud build-up during the summer months (NMEI, 1974, p.40-41).

Relative humidity in New Mexico is generally low. It remains below 20% much of the time, and readings to 4% have been recorded. The large diurnal variations in temperature cause a large difference in maximum and minimum relative humidities (NMEI, 1974, p. 41).

There are no air-circulation data for the proposed mining area, but a 4-year summary of the winds at the Langmuir Laboratory about 17 miles southwest of Socorro (MapA)(elevation 10,630 feet MSL) may be useful for some purposes and is presented in Table 2 of Appendix V. It should be noted that air circulation patterns in northwestern New Mexico are governed by the local topography and the daily surface heating regime (NMEI, 1974, p. 41-45).

Severe weather occurrences are uncommon in the Jackpile-Paguate area although flash floods and severe water run-offs which result in considerable erosion are usual experiences in the July-August period when there is significant precipitation. Summer thunderstorms are occassionally accompanied by high winds and small hail (1/2-inch diameter or smaller), but large hail (larger than 3/4-inch diameter) is infrequent. Heavy snows (defined by the National Weather Service as 4 inches in 12 hours or 6 inches in 24 hours at lower elevations) may occur six to twelve times per year. Tornadoes in the area would be rare but not impossible (White, 1976, oral communication).

The proposed mining operations should have no effects on the meteorological conditions in the area, nor vice versa.

2. Air Quality

Particulate data for the Paguate area collected by the New Mexico EIA in 1975 indicate an annual geometric mean of 36.8 ug/m^3 for total suspended particulate matter. This is well below the maximum allowable concentration of 60 ug/m^3 under the EIA standards and 75 ug/m^3 under Federal standards (see Appendix VI for air quality regulations and data)(Rinaldi, 1976, written communication).

The proposed mining operations should have no significant adverse effects on the air quality in the area. However, a certain amount of dust would be created by the site preparation and road construction phases of the initial surface operations, by vehicular traffic on the access and haulage roads, and by reclamation operations. This dust would be only temporary, and problems could be avoided or minimized by applying adequate amounts of water to excessively dusty areas and roads. Anaconda has agreed to control airborne dust in Part 2. Stipulations, Number 1. Airborne Dust Suppression in the Description of Request for Changes in Mining Plan.

Ore and waste rock stockpiles should not be significant sources of dust due to the large size of the smallest run-of-mine particles and the natural dampness of the material. High winds could cause a small amount of airborne dust, but most of it should settle within a short distance because of the fairly heavy particle weight. Furthermore, the ore stockpiles would be quite small (1 or 2 days production maximum), and the waste rock would be used to level the mine yard and would, therefore, be compacted to a certain degree. The loading and unloading of ore and waste material should not create any appreciable amount of dust.

Air pollution from the exhaust gases of surface equipment (loaders, bulldozers, haulage trucks, etc.) should be insignificant due to the small amount of equipment required and the use of appropriate pollution control devices.

Dust problems in the mine itself should be minimal due to the natural dampness of the mine workings and should have no effect on the surface atmosphere. Contamination of the mine atmosphere by fumes from the detonation of explosives, radon gas from radium disintegration, and exhaust gases from approved diesel equipment would be maintained within acceptable limits by the mine ventilation system. Frequent monitoring by authorized mine personnel, Mining Enforcement and Safety Administration (MESA) inspectors, and the New Mexico State Mine Inspector would assure compliance with the applicable regulatory standards and would provide the basis for any required changes in the ventilation system.

The contaminated mine air exhausted through the various ventilation shafts (heated air and some fine particulates) would be rapidly dissipated in the ambient surface atmosphere without adverse environmental effects. The 1971 and 1972 analyses of large ambient surface air samples by the Kerr-McGee Corporation at its uranium mines in the Ambrosia Lake district indicated no radiological contamination over the natural background count (0.15 working levels concentration) within a 150-foot radius of the bore-hole exhaust vent and a very low level of concentration at a distance of 25 feet. Similar results from parallel testing during the same time period were obtained by Edward P. Kaufman, Program Manager, Radiation Protection, New Mexico EIA (Cleveland, 1975, oral communication).

The evaporation of the water retained in the settling ponds and sewage lagoon could create a local high moisture anomaly in the air. This should not have a significant adverse effect on the environment but could, in fact, be beneficial to the local vegetation, There should be no problems with odors from the sewage lagoon, but chemical treatment of the lagoon water could reduce any odor problem to an acceptable level.

The Anaconda Company has established a high volume air sampling station and currently monitors ambient air concentrations on a continuous basis. According to the company, the particulate levels have been well below the regulatory standards. The company plans to expand the program by establishing meteorology monitoring stations and by locating additional air sampling stations at strategic locations (The Anaconda Company, 1973, p.10).

3. Noise

Noise created by the proposed operations should not be a significant problem since there are no residences in, or in close proximity to, the area. The majority of the operations that would create noise would be conducted underground and would not affect the surface. Underground noise would be maintained within acceptable limits as prescribed by MESA and the New Mexico State Mine Inspector by the use of recommended muffling devices on mining equipment and by the use of hearing protection equipment by mine personnel.

The major sources of noise on the surface would be the loading and haulage equipment and the fans on the ventilation boreholes, neither of which should create a significant adverse effect. Noise from the small amount of loading and haulage equipment would be intermittent and not all of the vent holes would be equipped with fans at one time.

C. Hydrology

1. Surface Water

The main stream in the Laguna District is the perennial Rio San Jose (Map F) which is entrenched 20 feet or more over most of its length. It drops from an altitude of about 5,900 feet to less than 5,600 feet from west to east and joins the Rio Puerco, a tributary of the Rio Grande, a few miles southeast of the district. The Rio Puerco drains the west flank of the Nacimiento Mountains but flows continuously only during the wet season (Moench and Schlee, 1967, p. 4).

The Rio San Jose is joined by several arroyos from the north and south, but the majority of these flow only after heavy precipitation. The largest such arroyos are the perennial Rio Paguate and the intermittent Arroyo

Conchas which drain the area to the north and the Arroyo Colorado which drains the broad valley to the south. All the main streams and tributaries are entrenched into arroyos cut in the alluvial fill of the valleys. The arroyos carry large quantities of water immediately after heavy precipitation and occassionally the waters rise over the banks and spread out as sheet floods (Hunt, 1937, p. 4).

In the mining lease area, the main streams are the Rio Paguate and Rio Moquino. These so-called perennial streams are sustained by springs that issue from mesas northwest of Paguate (Dinwiddie, 1963, p. 218), and they join in the Jackpile-Paguate mine area to form the Rio Paguate which flows into the Paguate Reservoir and hence into the Rio San Jose. The steeply sloping surface of the proposed mine area is cut by several northeast trending dry arroyos that channel surface runoff toward the Rio Paguate during heavy precipitation.

The main bodies of ponded water in the area are the Paguate Reservoir, the New Laguna Reservoir and a small unnamed reservoir in the village of Paguate (Map F). The Paguate Reservoir is about 2 to 3 miles southeast of the proposed mines and retains the flow of the Rio Paguate about one-half mile northeast of its intersection with the Rio San Jose. The New Laguna Reservoir is located on the Rio San Jose about 5 miles southwest of the proposed mines. The small reservoir in Paguate retains the flow of some small streams flowing from mesas to the northwest. There are numerous small, natural or man-made water catchments outside the proposed mining area, but these probably hold water only intermittently due to evaporation and seepage.

At the present time, no major use is made of the surface waters in the area. At some time in the past, the water in Paguate Reservoir was used for irrigation purposes, but this reservior and the New Laguna Reservoir are currently nonfunctioning due to sediment filling.

The P-15/17 surface facilities capable of affecting surface water runoff would be concentrated in North Oak Canyon. This drainage has about 1 square mile of watershed above the proposed minesite but is normally dry except when appreciable precipitation falls within this area. Any surface runoff in North Oak Canyon is confined to a single drainage at and below the proposed location of the adit portal. This permits close and definitive observation of the runoff, and Anaconda proposes to install an automatic water sampler and a measuring weir for monitoring flow in the Canyon downstream from the mine's service facilities. Drainage flow data and water quality analyses would be submitted quarterly to the Area Mining Supervisor (see Part 2. Stipulations, Number 2. Monitoring of Surface Runoff Water in Description of Request for Changes in Mining Plan).

The ventilation shaft sites and associated powerlines and access roads on Black Rim Mesa would not be expected to significantly affect the quantity or quality of surface runoff in that area.

2. Ground Water

The principal aquifers in the Jackpile-Paguate minesite area are the alluvium along the Rio Paguate, the Tres Hermanos Sandstone Member of the Mancos Shale in the western part of the area, and the sandstone beds of the Brushy Basin and Westwater Canyon Members of the Morrison Formation throughout the area (see Table 1, Appendix II)(Dinwiddie, 1963, p. 217).

Quaternary alluvium is exposed along the Rio Paguate and the tributary Rio Moquino. Although the alluvium along the Rio Moquino and the lower part of the Rio Paguate is not used as an aquifer because of the water's high dissolved solids content, the water in the alluvium along the upper part of the Rio Paguate is potable. Wells drilled west of Paguate to test the quality and quantity of this water showed that the water was suitable for domestic use and that yields of 10 to 35 gallons per minute (GPM) could be sustained. In one well, water in the lower part of the alluvium was under artesian pressure and flowed at a rate of 13 GPM (Dinwiddie, 1963, p. 218).

The sandstones in the Tres Hermanos Sandstone Member are the only units of the Mancos Shale that yield potable water, generally yielding from 5 to 20 GPM. Although larger yields have been reported, yields greater than 20 GPM would not be expected in the area (Dinwiddie, 1963, p. 217-218).

The Westwater Canyon Member of the Morrison Formation yields a small amount of potable water, between 8 to 10 GPM, to a few wells in the area. The sandstone beds of the Brushy Basin Member reportedly yield as much as 20 GPM of water east of the area, but this water has a rather high dissolved solids content. The Jackpile unit of the Brushy Basin is not considered to be a good aquifer although it reportedly yields from 8 to 10 GPM of water to one well in the area (Dinwiddie, 1963, p. 217).

The Quaternary alluvium aquifer is recharged by runoff which infiltrates to the west and north. The Brushy Basin and Westwater Canyon aquifers crop out in the valleys and the Tres Hermanos aquifers crop out extensively in the area; recharge of these aquifers is probably limited to precipitation on and runoff over the outcrops (Dinwiddie, 1963, p. 217-218). It is doubtful that there is significant communication between aquifers, and there are no known natural discharges for the aquifers in the area.

There are numerous wells in the Jackpile-Paguate area which supply water for domestic and industrial use. The Paguate municipal water supply is a flowing artesian well completed in the alluvium along the Rio Paguate at a depth of about 75 feet. Three other wells in the area, believed to be former uranium exploration drill holes equipped as water wells, are the property of The Anaconda Company and are used to supply potable water as well as water for equipment washing, etc. (Map G)(EPA, 1975, p. 57-58). One of these wells supplies domestic water for the Jackpile Mine offices and the mine housing area from the Jackpile sandstone at a rate of about 35 GPM. The P-10 Mine well is completed in the Brushy Basin Member to a depth of 465 feet and yields about 35 GPM for the mine's surface and underground uses (Mudgett, P-10, 1975, p. 10-11). Map G shows the locations of several wells in the Jackpile-Paguate minesite, but only two or three of the wells are still productive.

Water for the proposed mine would be supplied by the existing Shop well and a supplemental well located on the surface near the underground end of the adit. The supplemental well would be completed in sandstone units of either the Brushy Basin Member or the Westwater Canyon Member of the Morrison Formation depending on the quantity and quality of the water from the producing sands. The mine would require about 50 to 100 GPM from both wells.

The proposed mining operations would have only minor impacts on ground water availability in the Jackpile-Paguate area as acknowledged by the Water Resources Division's hydrologist in his memorandum reports (Appendix VII). The P-15 and P-17 ore bodies are located up the dip slope from the operating P-10 Mine, and would, therefore, probably be at least partially within the cone of depression created by this pressure sink. Furthermore, the ore bodies are located in strata that are naturally drained by surrounding ravines and canyons. The Jackpile Sandstone receives very little recharge and crops out close to the proposed mines. According to the hydrologist's memorandum report, "In this area mining will be done at or just below the water table, so yields from the relatively impermeable material will be low and drawdown will be small."

In addition to mine dewatering, the proposed mine's water wells would require the extraction of ground water from one or more aquifers in the area. However, because the mine's water requirements are modest, this additional utilization of ground water should not be a significant impact.

The aquifers in the area should not be disturbed significantly by subsidence of the strata overlying the mining voids since such subsidence should not be excessive or extensive as discussed in Section II.A.5.

The pumping rate of the P-10 Mine and the yields of the P-10 and Shop wells would most likely reflect any effects on the ground water content of the Jackpile Sandstone aquifer from the P-15/17 operations. Quarterly reports of these data are now submitted to the Area Mining Supervisor and will continue. It would be advisable to have included in these reports the same type of data for the supplemental well that would provide water for the P-15/17 underground uses.

3. Water Quality

Water quality data for the surface waters in the Jackpile-Paguate area are scarce. According to a study conducted by the U.S. Environmental Protection Agency (EPA) in 1975, stream samples taken from the Rio Paguate and the Rio Moquino (Table 1, Appendix VIII) showed a definite increase in Radium-226 (Ra^{226}) and selenium concentrations downstream from the Jackpile mining operation indicating that precipitation runoff from the disturbed land surface adds radiochemical bearing solids to these streams. However, it should be noted that only one sample was taken at each location and that the radium concentrations were less than 5 pCi/l which is less than the State of New Mexico's standard of 30 pCi/l. Furthermore, the selenium concentration of the Paguate Reservoir and the Rio San Jose were less than detection limits (EPA, 1975, p. 31, 33, 35).

The proposed action would have very little effect on surface water quality due to the absence of any major surface water sources in the proposed mining area. At its closest point, the Rio Paguate is about 1 mile from the proposed mine. Surface preparation, road construction, waste rock storage, and possibly reclamation work could increase the sediment loads of the small dry arroyos in the area during surface runoff; however, this should be of minor consequence since its time duration would be short and it would have little or no effect on the Rio Paguate. Surface runoff over the waste rock and ore stockpiles could result in the transport of radiochemical species a short distance from the mine. Adequate protection would be provided by using appropriate measures to control surface runoff and by effectively monitoring surface runoff to detect any problem areas.

Degradation of surface waters by the seepage of the radioactively contaminated water from the settling ponds would be prevented by lining the ponds with an impervious clay, plastic or concrete. The New Mexico EIA does not require the use of seepage monitoring wells with lined settling ponds, and the sewage lagoons would comply with State standards. Although a failure of the sewage lagoon or settling pond impoundments, caused by excessive surface runoff for example, would be unlikely, adequate measures would be taken to protect against this possibility. This would consist of constructing berms and/or ditches around these areas to divert runoff.

By comparing Table 2 and the Water Quality Criteria in Appendix VIII, it can be concluded that the ground water quality in the Jackpile-Paguate area is generally good. The Table 2 values that are outlined indicate areas where the water quality standards are not met.

During the EPA study conducted in 1975, four wells in the vicinity of the Jackpile-Paguate open-pit mining operations were sampled with concentrations of Ra^{226} ranging from 0.18 to 3.7 pCi/l (Figure 1, Appendix VIII). The lowest value (0.18 pCi/l) was recorded at well #233 which is the Paguate municipal water supply. The other wells, believed to be former uranium exploration holes equipped as water wells, are the property of The Anaconda Company and are used to supply potable water and water for equipment washing, etc. The quality of the water from these three wells is probably representative of the Jackpile Sandstone unit of the Brushy Basin Member of the Morrison Formation, the principal ore bearing unit in the Laguna District, but the water may contain elevated levels of radium due to uranium mining activities. The high value of 3.7 pCi/l exceeds the U. S. Public Health Service Drinking Water Standard of 3 pCi/l and was recorded at the Jackpile New Shop Well which is a source of potable and nonpotable water. The EPA subsequently recommended that the continued consumptive use of this water be stopped (EPA, 1975, p. 57). Further sampling by Anaconda (Table 3, Appendix VIII), however, indicates an Ra^{226} concentration of 1.0 pCi/l in the water from this well.

None of the wells sampled by the EPA were above the maximum permissable concentrations for the other common isotopes of uranium, thorium, and polonium (EPA, 1975, p. 6), but the Paguate water supply contained the maximum recommended level for selenium (0.01 mg/l)(EPA, 1975, p. 59). Although the EPA noted that the impacts of mining on ground water quality downgradient from the mining operations were unknown due to the lack of adequate monitoring wells, it also stated "No adverse impacts from mining on the present water supply source for Paguate are expected." (EPA, 1975, p. 6).

Ground water seeping into the P-15 and P-17 mine workings would become radioactively contaminated because the primary minerals to be mined would be exposed to the oxidizing conditions created by the excavation of the workings. Leaching of the very low grade mineralization remaining in the rocks surrounding the mined out areas would also occur. Both of these conditions could result in the mine's discharge water having radioactive concentrations greater than recommended limits. Mine discharge water impounded within the Paguate Pit contained 190 pCi/l of radium and 170 pCi/l of uranium in 1970 (EPA, 1975, p. 6). This radiological contamination would require that the mine's discharge water be impounded for subsequent evaporation of the liquid portion. Sediments that would collect in the settling ponds would be removed periodically and transferred to ore or waste stockpiles depending on their U_3O_8 content. It is anticipated that the amount of water to be impounded at the mine would be small as discussed in Section II.C.2.

Following the termination of mining operations in the P-15 and P-17 area, ground water accumulating in the voids created by the mine workings would also become radiologically contaminated. However, the impervious nature of the shales above and below the Jackpile sandstone unit should prohibit substantial vertical migration of this water, and typical changes in the lithologic character of the unit should tend to restrict and localize lateral migration (Mudgett, P-10, 1975, p. 12).

The radioactive contamination of ground water in the proposed mining area should not be a major adverse impact due to the small amount of water that would probably be encountered. However, additional protection for the area's ground water resources could be provided by adequate monitoring to determine the interactions between the aquifers and the mining operations. The quality of the water in the undisturbed Jackpile Sandstone has been established from samples taken from the P-10 and Shop wells. Further sampling of these wells would provide information on any effects that the mining operations might have on the quality of the water in the aquifer outside the ore zones. Water sample analyses from these wells are now submitted quarterly to the Area Mining Supervisor and will continue. It would be advisable to have included in these reports the same type of analyses for the supplemental well that would supply water to the P-15/17 underground uses.

Degradation of the area's ground water by the infiltration of contaminated surface water should be very minor due to the relatively low amount of surface runoff occurring in the area and the lithologic characteristics of the strata. Measures used to prevent surface water contamination, as discussed above, should be adequate to also prevent ground water contamination from such events as failure of the sewage lagoon and settling ponds, seepage, etc.

Impacts on the surface and ground water resources of the Jackpile-Paguate minesite area from the uranium mining operations were discussed at the July 8, 1977, meeting between the USGS, BIA, Pueblo of Laguna and Anaconda. It was pointed out that it would be best to assess these impacts in regard to both quantity and quality on a cumulative basis, and that this would be possible in the EA of Anaconda's comprehensive plan. Anaconda proposes a detailed surface and ground water monitoring program for the detection and assessment of any such impacts.

D. Land Use

1. Land Use in Lease Area

All of The Anaconda Company's leases are used for mining purposes except for a small centrally located housing area for about thirty key mine personnel. This area is on Lease 1, well removed from the surface mining activities. The property is posted and fenced at all points of eacy access, and a security guard station on the principal access road is manned 24 hours a day (Mudgett, P-10, 1975, p. 5). There are no residences in the proposed mining area.

Lease 1, which is also called the Jackpile Mining Lease, contains the company's operating open-pit uranium mines, the Jackpile and Paguate Pits, as shown on Map G. Although both pits are separate mining operations, they are commonly referred to as the Jackpile-Paguate Open-Pit Mine, and they occupy an area of something less than 12 sections in Townships 10 and 11 North, Range 5 West, N.M.P.M. (The Anaconda Company, 1973, p. 1). The Jackpile ore deposit, which outcropped on the south side of a low mesa, was discovered in November 1951 and active mining began in 1952 (Moench and Schlee, 1967, p. 87). The Paguate ore body, a short distance west of the Jackpile, was discovered by core drilling in June 1956, and ore was being mined by 1963 (Moench and Schlee, 1967, p. 97). The mines are currently operating without an approved mining plan (or plans), but The Anaconda Company has submitted a comprehensive mining and reclamation plan for these operations to conform with 30 CFR Part 231 and 25 CFR Part 177.

Mining of the Jackpile and Paguate deposits is accomplished using conventional open-pit methods using rotary blasthole drilling rigs, ammonium nitrate-fuel oil blasting agents, electric shovels, and diesel powered front-end loaders and haulage trucks. The ore is stockpiled, blended, and then shipped by rail (AT&SF) to the compny's Bluewater Mill about 50 miles to the west. As of 1973, about 11,300,000 tons of ore had been mined and milled resulting in 57,676,900 pounds of yellowcake (U_3O_8). At that time 8,314,700 tons of remaining ore reserves were indicated, and it was estimated that the mining of these reserves would be completed sometime during the period of 1983 to 1985. In 1973, it was expected that about 24% of the indicated remaining reserves would be mined by underground methods (The Anaconda Company, 1973, p. 2-4).

The Jackpile Mining Lease also contains two underground mine workings (See Map G). The Woodrow Mine, about 1 mile east of the Jackpile Pit, was discovered in 1951. Mining of the deposit, which was in a nearly vertical sandstone pipe, began in 1954 through a vertical shaft and ended in 1956 when the square-set timbering collapsed. The mine produced about 5,500 tons of uranium ore (Moench and Schlee, 1967, p. 96). The H-1 Mine, a small adit mine, was developed for the extraction of about 38,000 tons of uranium ore by longwall and sub-level stoping methods. Operations began in March 1973 under an approved mining plan, and the ore was subsequently exhausted and the mine abandoned in April 1975 (The Anaconda Company, H-1, 1972, p. 1-3).

The P-9-3 and P-11 workings were planned to be small adit mines developed from the north and east walls of the inactive P-9-1 open pit for the extraction of about 81,000 tons of uranium ore by a modified sub-level room-and-pillar stoping method. The operations were approved November 17, 1975, (Mudgett, P-9-2, 1975, p. 1-2), but they have subsequently been postponed because it may be feasible to mine the ore with open-pit methods (Gibbs, 1976, oral communication).

Lease 4 contains various underground mine workings as well as some facilities for the Paguate Pit operations (Maps B & G). The P-9-2 Adit Mine Project, approved in February 1974, was developed from the south wall of the small, mined-out P-9-1 open-pit for the extraction of about 58,000 tons of uranium ore by longwall and sub-level modified room-and-pillar stoping (Mudgett, P-9-2, 1973, p. 1).

The P-10 Mine (Map B) is currently producing about 700 tons of uranium ore per day by modified room-and-pillar stoping with sublevel track haulage. Access to the mine is provided by an inclined shaft. The mining plan for the project was originally approved August 31, 1973, with major changes in the plan being approved October 19, 1973. Further changes in the plan which provided for the mining of ore in the P-7 area by extending the P-10 workings were approved December 12, 1975. According to The Anaconda Company, the P-9-2 area will be mined out by about mid-1977 while the P-10 and P-7 ore reserves will be exhausted by mid-1982 (Gibbs, 1976, oral communication).

The proposed mining operations would not affect the present use of the involved lands because the leases are used exclusively for mining purposes. This area has been a well known mining district since about 1956 when the Jackpile Mine was the largest single producer of uranium in the United States, and possibly in the world (Moench and Schlee, 1967, p. 1). The proposed mining area has been impressed with numerous drilling sites and access roads from exploration and development drilling activities.

2. Land Use in Surrounding Area

The lands adjacent to The Anaconda Company's mining leases are used exclusively by members of the Laguna Tribe for residential and livestock grazing purposes. The primary domestic animals encountered are sheep and cattle, but a few horses do roam in the areas. Agriculture is severely limited by the lack of sufficient precipitation and is probably restricted to small garden plots worked by residents of the areas.

The community closest to the proposed mining area is the small Laguna Indian village of Paguate (Map A) which is about 2 miles to the north. As of January 1, 1975, the census showed a resident and non-resident population of 1,383 for Paguate (Starcevich, 1976, oral communication); however, the actual resident population for the village is close to 300 (The Anaconda Company, 1973, p. 9). Paguate has no retail or public service facilities such as restaurants, service stations, motels, schools, hospitals, etc., except for one very small general merchandise type store which is extremely limited in available goods. Approximately 2 to 5 miles north of Paguate are the even smaller settlements of Bibo, Cebolleta, Cebolletita, and Moquino.

The Indian village of Laguna, or the Pueblo of Laguna, is located about 5 miles south of the proposed mining area (Map A). This small village, as of January 1, 1975, had a resident and non-resident population of 1,449 although, as in the case of Paguate, the actual resident population is probably much less. There are more services here than in Paguate but they are still limited to a few small stores and service stations. The Laguna-Acoma High School and an elementary school are located in Laguna (Starcevich, 1976, oral communication).

The closest town offering a wider variety of goods and services is Grants which is about 30 miles west of Laguna via Interstate Highway 40 (Map A). Grants is an incorporated city of 8,768 (1970 census), and about 3 miles west of Grants is the village of Milan which has a population of 2,185 (1970 census) (ISRAD, 1972, p. 22-23). In 1967, Grants-Milan had 130 of the 327 retail establishments in Valencia County (ISRAD, 1972, p. 87), and in 1970, Grants had 23% of the county's labor force (NMEI, 1975, p. 90). Grants also has a hospital and a branch campus of New Mexico State University (NMEI, 1975, p. 125).

Albuquerque, the county seat of Bernalillo County, is about 46 miles east of Laguna via I-40 (Map A). This metropolitan city of 243,751 (1970 census) offers a full range of goods and services for both private and commercial needs (ISRAD, 1972, p. 22-23).

Access to the Paguate area is provided by paved State Highway 279 which joins Interstate Highway 40 at Laguna (Map A.). I-40 connects Laguna with Grants-Milan to the west and Albuquerque to the east. Greyhound Bus Lines, Inc., and Continental Trailways, Inc., stop daily for passengers in Grants on their routes from Albuquerque to Los Angeles, California, and passenger and freight rail service is provided by the AT&SF railroad which also passes through Grants-Milan and Albuquerque. Although Grants has an airport, Albuquerque has the closest commercial air service (NMEI, 1974, p. 20).

Recreation in the Paguate-Laguna area is confined primarily to outdoor activities such as picnicking, camping, sight-seeing, and hunting, the majority of which are conducted in the Cibola National Forest on and to the west of Mount Taylor. These activities can be classified as seasonal and intense (NMEI, 1974, p. 16, 34). Camping, fishing, boating, and swimming are permitted at Bluewater State Park (Bluewater Lake) which is about 21 miles west of Grants via State Highway 412. The major recreational centers in the area are Grants and Albuquerque.

Due to their size, nature, and location, the proposed mining operations would not have any effects on land use in the surrounding areas. The local communities may be affected to a minor extent, and these effects are discussed in Section II. F. No impacts on the local transportation services would be expected since ore shipment would be by company equipment and existing rail facilities and schedules.

3. Historical and Archaelogical Sites

The Laguna Pueblo and the San Jose de la Laguna Mission and Convento (in the Pueblo) at Laguna are listed in the National Register of Historic Places, but both are well removed from the proposed operations (about 5 miles) and would not be affected. The Grants Lava Flow which extends about 25 miles south of Grants between State Highway 117 on the east and 53 on the west (Map A) is eligible for listing in the National Registry of Natural Landmarks, but it, too, is well removed from the proposed projects.

Archaeological surveys have been completed for the vent hole sites, powerlines, and access roads on Black Rim Mesa and for the area of the adit portal, roads, and powerlines throughout North Oak Canyon. Copies of these survey reports are included in the Description of Request for Changes in Mining Plan, and the accompanying surface facilities map shows the areas surveyed and the archaeological sites located. The surface facilities have been designed to avoid and preserve as many of the sites as possible, and mitigation of the sites that cannot be avoided is currently in progress.

Archaeological clearance for the proposed action, as well as mitigation of the unavoidable sites, is the responsibility of the archaeologist for the Bureau of Indian Affairs, Albuquerque Area Office, Branch of Land Operations. Anaconda is in the process of obtaining the required clearance from this office and would not begin surface operations until this clearance was granted.

4. Scenery and Aesthetics

The proposed action would not affect the scenic or aesthetic values of any of the prominent landmarks in the area such as Mount Taylor, the Laguna Pueblo, Mesa Chivato, and the Cibola National Forest. The vent holes and their powerlines and access roads should have only a minor effect on Black Rim Mesa. The more visible equipment such as the vent tubes and fan housings would be painted a dark color to reduce their visibility, and the road fill and berms would be covered with local material of a color compatible with their surroundings. The mine and portal yards, buildings, sewage lagoon, and settling ponds would be situated in North Oak Canyon out of sight of the general public. The mine workings would be underground and would not create a visual impact.

5. Reclamation Potential

The reclamation potential of the land in the area has not been adequately determined, but the writer feels that this potential is only poor to fair. This estimate is due to the fact that most uranium related reclamation work (primarily in uranium exploration) has met with only limited success due to soil characteristics and the lack of sufficient moisture (precipitation).

These conditions would also surely determine the results of any revegetation programs in the Jackpile-Paguate area.

The Anaconda Company is currently conducting revegetation experiments on inactive waste dumps in order to adequately assess the land reclamation potential. The U. S. Conservation Service has recommended such seed mixtures as sideoats, gramma grass, western wheatgrass, and chamisa brush, and test plots have been planted for observation (The Anaconda Company, 1973, p. 7). Continued experimentation by Anaconda and other companies in northwestern New Mexico's coal and uranium industries should improve the land's reclamation potential by providing new and improved reclamation techniques.

Anaconda's comprehensive mining plan presents detailed information on the current and proposed reclamation of the Jackpile-Paguate minesite. Some of this material regarding equipment, techniques, and seed varieties is given in Appendix XIII.

E. Fauna and Flora

Due to the intense mining activity in the adjacent Jackpile-Paguate area and the absence of any perennial surface water in the P-15 and P-17 areas, wildlife in or near the project area is probably limited to small rodents (rabbits, mice), small predators (foxes, coyotes, bobcats), small birds (finches, sparrows, jays), insects, and reptiles common to northwestern New Mexico. The presence of a stable, resident predator population is doubtful because of human presence and activity, and most of the birds are also probably transient inhabitants. The largest wild animals in or near the area are mule deer which inhabit the slopes of Mount Taylor and the mesas to the north (The Anaconda Company, 1973, p. 9). No endangered species are known to be present in the area as residents (Mudgett, P-10, 1975, p. 6). Several almost wild horses that belong to the Laguna Indians roam within the proposed mining area (Gibbs, 1976, oral communication).

The proposed operations would not have a significant impact on the wildlife resources of the area because of the small number of actual permanent wildlife residents. A small amount of habitat would be disturbed throughout the life of the operation (about 38 acres) resulting in the displacement of a small amount of wildlife, but there is ample habitat in the surrounding areas to accomodate any displaced species. The mine yard, settling ponds, sewage lagoon, and vent hole areas would be fenced throughout the operation's life to keep out the larger species, and the settling ponds and sewage lagoon should not be detrimental to any waterfowl that might be attracted to them. Traffic on the haulage and access roads could be a hazard to wildlife, but this should not be significant.

If the reclamation program was successful in establishing grassland vegetation in the area, there could be a slight decrease in the number of woodland species and a corresponding increase in the number of grassland species, but substantial reinhabitation of the area would probably not occur until completion of the reclamation and revegetation program. No significant alteration of species composition would be expected since the amount of habitat involved is quite small. The establishment of grassland vegetation would be beneficial to domestic animals, and possibly to wildlife, by improving grazing conditions.

The vegetation in the lowest valley and mesa areas around Mount Taylor is characteristic of the Upper Sonoran life zone consisting of flowers, grasses, sagebrush, and composites such as goldenrod, rabbitbrush, and sunflowers. The trees in this zone generally occur on hillsides and mesas and consist of one-seeded juniper, the nut pine (piñon), and the cane cactus.

Greasewood is common on alluvial flats adjacent to watercourses, and there are groups of the common valley cottonwood (Hunt, 1937, p. 37).

The rough boulder strewn surface of the proposed mining area supports a moderate but scattered growth of native grasses and desert shrubs and a moderate to heavy growth of juniper trees. There are widely scattered occurrences of cacti (Photos I, J, K). Past exploration and development drilling activities have impressed the area with numerous drill sites and access roads.

The proposed operations would result in the destruction of the vegetation on about 38 acres of the land surface. This should not be a major impact since the vegetative cover is moderate and scattered as noted above. The reclamation program would attempt to establish herbaceous growth on the area, and the range conditions on the 38 acres would be greatly improved if the program was successful. If herbaceous growth could not be established, it might be possible to revegetate the area with native species, such as juniper seedlings. The writer has no knowledge of any such attempt being made in other uranium related reclamation programs; however, during the inspection of various companies' exploration activities, it has been observed that natural revegetation by native species usually begins within an intermediate time period after the completion of leveling and grading operations (estimated at 3 to 6 months).

Appendix XII contains a list of representative fauna and flora expected to occur in the Jackpile-Paguate mine area, data on biological sampling in the mine area, and a discussion of endangered and threatened species possibly occuring in the mine area. This information was compiled by Dames & Moore and was presented in Anaconda's comprehensive mining and reclamation plan (pgs. 2.1-47 through 2.1-57 and Appendix A).

F. Socio-Economic Conditions

The proposed operations should not cause a large influx of new people into the area since Anaconda would use local labor as much as possible. In compliance with lease terms, Anaconda gives the Laguna Indians priority in employment at all its Jackpile-Paguate mining operations, and, as of October 1975, about 90 percent of the Company's 372 mine personnel were Lagunas (Mudgett, P-10, 1975, p. 5). It is anticipated that the majority of the 200 employees required by the mine would be supplied by the local populace although some positions could be filled by employees transferred from other completed underground operations. A few permanent employees could be expected to move into the area, and contractor's mine development personnel would relocate in the area temporarily.

Any socio-economic impacts on the villages of Paguate and Laguna should be very minor due to the very limited supply of services available in these communities. Some Lagunas employed at the mines could want to relocate in Laguna or Paguate which could require additional housing, but this should not be of major consequence. The Anaconda Company has cooperated with the Laguna Tribe in housing construction in Paguate.

Any major socio-ecomomic impacts would most likely fall on the city of Grants since any new permanent workers, and the temporary labor force, would probably relocate there. According to recent newspaper articles, Grants-Milan is having trouble in providing adequate housing and public services for a population increasing due to the expansion of uranium activities in this area. Although the influx of permanent and temporary workers for the proposed mine could put an additional strain on these services, the small number of workers expected to relocate should not create a significant effect. The mitigation of cumulative socio-economic impacts is the responsibility of appropriate public agencies such as city, county, and state planning commissions.

The proposed operations should have very little effect, if any at all, on the metropolis of Albuquerque which would be capablo of managing any such impact.

The most significant socio-economic impact resulting from the proposed action would be the generation of new income. According to lease terms, the company would pay royalties on the ore mined to the Pueblo of Laguna; as of November 1973, the Jackpile-Paguate mining operations had paid about $25,000,000 in such royalties to the Pueblo (The Anaconda Company, 1973, p. 3). Direct employment during the mine's life would also result in annual disposable income. It is expected that most of this income would be respent within the region which could have a multiplier effect on other sectors of the economy. Additional federal, state, and local taxes that would be paid by

Anaconda and its employees shoud offset any increased governmental costs that would be caused by the proposed action.

Increased income in the area could improve the standard of living for many families, and direct employment could improve the self-esteem and mental health of many people who are currently unemployed or underemployed. Because the Lagunas would be given preference in hiring, most of the benefits would be directly, or indirectly, advantageous to the Laguna Indian Tribe, as would the royalty benefits. Although many experienced workers would be unemployed at the close of operations, the training and experience acquired should help these workers find new jobs more easily.

The proposed action should not have any significant effects on the cultural values of the area or of the Laguna Indians in particular. It seems that all Indians have the general belief that nature is a strong force to which man must adapt rather than control. Although this belief causes a reluctance to support activities exploiting the Indians' natural resources, it also provides strong support for the restoration of the land following such activities. It also seems that although Indians do value work, they work to maintain their families and themselves, not to achieve social prestige. This evidently causes a strong tendency to reject monetary incentives once a relatively low level of income is reached. Indian males evidently often reject the role of "breadwinner" since it involves accepting wage labor, thus increasing the possibility of alcoholism and social dysfunction which can reslut in increased absenteeism and possibly the total rejection of work. According to Anaconda officials, absenteeism among the company's Laguna employees is quite high which necessitates the hiring of extra personnel who would normally not be required. (Gibbs, 1976, oral communication).

G. Health and Safety

Health and safety at the mine, both surface and underground, would be controlled by the Company's safety personnel in accordance with the standards and regulations of the New Mexico State Mine Inspector and the Mining Enforcement and Safety Administration. Periodic inspections of the operations by authorized personnel from these regulatory agencies would assure compliance with the applicable regulations and standards. The Anaconda Company currently operates active safety programs at both its mining and milling operations and has accrued numerous safety awards.

Vehicular traffic on the access and haulage roads could create hazards, but adequate warning signs and speed limits would be posted where necessary to control traffic in the mine area and minimize these hazards. Junctions of the roads and State Highway 279, if any, would be adequately posted to minimize hazards, but traffic at such intersections would probably not be heavy enough to create significant safety problems. The supervision of traffic on Highway 279 is the responsibility of State and local law enforcement agencies.

III. Alternatives to the Proposed Action

A. Alternative Methods

Although open-pit mining of the P-15 and P-17 ore bodies would probably result in nearly complete recovery of the ore reserves, utilization of this mining method is prohibited by the depths of the ore bodies. In addition, open-pit mining would have a much greater environmental impact on the area due to the large amount of land surface required for excavation, waste dumps, roads, etc. The final open-pit workings would also present difficult reclamation problems such as backfilling, etc.

It is possible that in situ leaching (solution mining) of the ore deposits would be both technically and economically feasible, and this mining method could possibly result in less surface disturbance than open-pit or underground mining. However, leaching would probably result in lower ore recovery due to solution losses, and these same solution losses could cause more serious ground water contamination than the other mining methods. Also, the water requirements of this type of mining could affect local water sources.

Mining of the ore deposits through the two vertical shafts originally proposed is both technically and economically feasible but does not offer significant advantages over the single adit method of entry. In fact, the single adit entry approach will allow consolidation of the necessary surface facilities, thereby reducing the amount of surface disturbance, scenic impacts on Black Rim Mesa, and possible traffic hazards associated with crossing Highway 279.

It would be possible to develop the P-15/17 ore bodies through the P-10 Mine. The only foreseeable advantage to this method would be that possibly less land surface would be occupied by surface facilities since an expansion of the existing P-10 facilities would probably be adequate. However, it will be necessary to remove the P-10 surface facilities some time in the future to accomodate open-pit expansion, and this method of development would also result in several problems in transporting the ore to the surface. The haulage level of the P-10 Mine would have to be expanded considerably to maintain adequate ore and waste production from the P-10 and P-15/17 workings; furthermore, an elevation difference of about 30 feet between the P-10 and P-15/17 ore bodies would severely complicate this expansion.

A decline similar to that of the P-10 Mine could also be used to develop the P-15/17 Mine, but the high ground support costs are somewhat prohibitive. This method of entry would not offer any significant environmental advantages over the proposed adit method. Relocation of the proposed adit and its portal would not offer any environmental advantages and is restricted due to ground support problems encountered in the Brushy Basin Shale.

Denial of the proposal would prevent mining of the ore deposits and would thereby preclude any environmental impacts associated with such mining activities. It would also, however, prevent the production of source materials necessary for the generation of electricity by nuclear powered generating facilities and would deprive the Pueblo of Laguna of direct and indirect benefits from royalties and direct employment incomes. If denied now, future development of the proposal would depend primarily on the prevailing economic conditions which are presently unpredictable.

B. Mitigating Measures

Should the proposed action be approved, mitigation of the resultant adverse environmental impacts would be provided by the measures listed below:

1. The effective use of water where practicable and possible would keep airborne dust created by the proposed operations to a minimum and

acceptable level (e.g., on the access and haulage roads). The Anaconda Company currently operates a high volume air sampling station on a continuous basis and plans to expand this program by establishing meteorology monitoring stations and additional air sampling stations. The environmental analysis of Anaconda's comprehensive mining plan will adequately discuss the cumulative air quality impacts of the open-pit and underground mining operations.

2. The effective use of water control structures and anti-erosion measures would minimize the possibility of any effects on surface water quality from the proposed operations (e.g., surface runoff over topsoil and waste rock stockpiles). Adequate monitoring of the surface drainage in the mining area would detect any deficiencies and provide a basis for corrective action.

3. The construction of water control structures around the sewage lagoon and settling ponds would minimize the possibility of a failure of one or more of these impoundments and would, therefore, minimize the possibility of water pollution which could result from such a failure.

4. Adequate monitoring of the ground and surface waters in the mining area would help determine the interactions between the proposed mining operations and the water resources and would provide a basis for determining any necessary mitigative measures. Anaconda's comprehensive mining plan contains a detailed monitoring program which has been designed to monitor both ground and surface waters in the open-pit and underground mining areas. Cumulative impacts on the water resources of the area will be adequately discussed in the environmental analysis of the comprehensive plan.

5. Mine support facilities such as ventilation holes and their associated equipment, roads, and powerlines could have minor effects on the appearance of Black Rim Mesa. These effects would be minimized further by camouflaging the facilities as much as is practical and possible, reclaiming any disturbed surface as soon as possible, and by avoiding skylining of the facilities as much as possible.
6. Adequate posting of warning signs and speed limits on the haulage and access roads and at critical intersections would minimize traffic hazards.

IV. Unavoidable Adverse Environmental Effects of the Proposed Action

Subsidence of the strata overlying the underground mine workings could have some surface expression depending on certain combinations of ore depth and thickness, mining extraction, and strength of the overlying strata. It is expected that any subsidence occurring would not be excessive and would not create a significant adverse impact.

The proposed operations would cause a certain amount of dust, but this would not be a major impact and could be minimized by using water. Air pollution from equipment exhaust gases should be insignificant. The mine's atmosphere would be contaminated by blasting fumes, radon gas, and exhaust gases, but the ventilation system and frequent monitoring by the appropriate regulatory agencies would maintain this contamination within acceptable limits. Any odor problems from the sewage lagoon should be insignificant and controllable by chemical treatment.

Any noise created by the operations would be insignificant due to the absence of any nearby residences.

The extraction of the P-15 and P-17 ore deposits would require the withdrawal of ground water from the Jackpile Sandstone, and the mine's water wells would withdraw additional water from the Brushy Basin or Westwater Canyon Members. This lowering of the ground water levels could cause water level declines in wells and a reduction in the flow of springs within the general vicinity of the mine. In addition, ore extraction would result in radiological contamination of the ground water seeping into the mine workings during the productive life of the mine and, to a lesser degree, following the termination of all mining operations with minor potential for migration within the Jackpile Sandstone. Surface preparations, waste rock storage, and possibly reclamation operations could affect the quality of surface runoff in the proposed mining area.

The support facilities of the proposed operation would have a minor effect on the appearance of Black Rim Mesa, an effect which would be totally or partially visible from State Highway 279.

Surface construction and preparation associated with the proposed mining operation would result in the temporary disturbance of about 38 acres of land surface and the destruction of the vegetation thereon. Any wildlife inhabiting this area, permanently or temporarily, would be displaced, probably until completion of the reclamation and revegetation program.

Extraction of the P-15/17 ore bodies would result in the depletion of a nonrenewable natural resource. Royalties would be paid for the ore extracted, and adequate mitigating measures and the reclamation program would minimize the environmental impacts of the mining operations. If not mined now, future development of the ore deposits would depend primarily on prevailing economic conditions which are not predictable at this time.

EXHIBIT I

Lease Number Laguna Number 4

Lessee (Permittee) The Anaconda Company

County Valencia State New Mexico

Date April 28, 1976, and August 24, 1977

Prepared by Dale C. Jones

Other Agency Representatives ____________

Affected Resources

	PROPOSED ACTION	Air Quality	Noise	Surface Water Quantity	Surface Water Quality	Ground Water Quantity	Ground Water Quality	Existing Land Use	Surrounding Land Use	Historical and Archeological Sites	Scenic, Recreational and Aesthetic Values	Endangered Species and Habitat	Plant Populations	Animal Populations	Nesting, Breeding or Migration Sites	Effect on Local Communities	Effect on Cultural Values	Public Health and Safety	Public Interest	Other
Construction	Roads, bridges, airports, railroads	\			\			\			\		\	\						
	Transmission lines, pipelines							\			\		\							
	Dams, impoundments, water diversions	\		\				\					\	\						
	Structures (mine buildings, etc.)							\			\		\	\						
	Exploration (drilling and trenching)																			
Mining	Surface excavation (surface mines, shafts, etc.)	\	\		\			\			\		\	\						
	Subsurface excavation	\	\			\	\													
	Storage (product, waste, spoils, water)	\		\	\			\					B\	\						
	Mineral processing and extraction facilities																			
	Post mining activities	\	\		\		\	B\			B\		B\	B\			B\			
Transportation	Trucks	\	\											\						
	Pipelines, conveyors							\												
	Railroad																			
	Other																			
Waste Disposal	Solid waste (spoils, tails, waste rock)	\			\			\					\	\						
	Sanitary wastes	\											B\							
	Liquid effluent discharge																			
Accidents	Spills, leaks, explosions				\															
	Geologic related hazards (subsidence, slope failure, etc.)					\	\	\										\	\	
	Structure failure (dams, impoundments, etc.)				\								\							
Other																				

INSTRUCTIONS: This matrix is to be completed during the onsite examination conducted with the surface managing agency and other agencies as required in the EA Guidelines. Adverse effects on existing conditions are to be indicated as follows: ☐ No effect ☐/ Minor effect ☒ Major effect Any beneficial effects are to be indicated by inserting a "B" in the appropriate box. Section XIV D, "Environmental Considerations of the Proposed Action" should be consulted for clarification of environmental factors to be considered in completing the matrix.

V. Matrix Analysis

VI. Determination and Recommendation

From the preceding analysis, it is concluded that the proposed action does not constitute a major Federal action significantly affecting the quality of the human environment in the sense of the National Environmental Policy Act, Section 102(2)(c). It is recommended that the proposed mining and reclamation plan for the P-15/17 Mine be approved subject to the following stipulations:

1. Prior to surface disturbing activities, Anaconda will obtain the necessary archaeological clearance for the project including procedures for mitigating any unavoidable archaeological sites.
2. Water sample analysis and pumping rate data for the supplemental well used to supply water for underground uses will be included with the quarterly reports presently submitted for the P-10 Mine.
3. Prior to the completion of the mining operations, Anaconda will submit a plan for the abandonment (sealing) of all the mine openings (adit portal or portals, vent shafts, etc.) to the Area Mining Supervisor for his approval.

Dale C. Jones

DALE C. JONES
Mining Engineer

I concur with the above determination and recommendations.

A. F. Czarnowsky

A. F. CZARNOWSKY
Area Mining Supervisor
Southern Rocky Mountain Area

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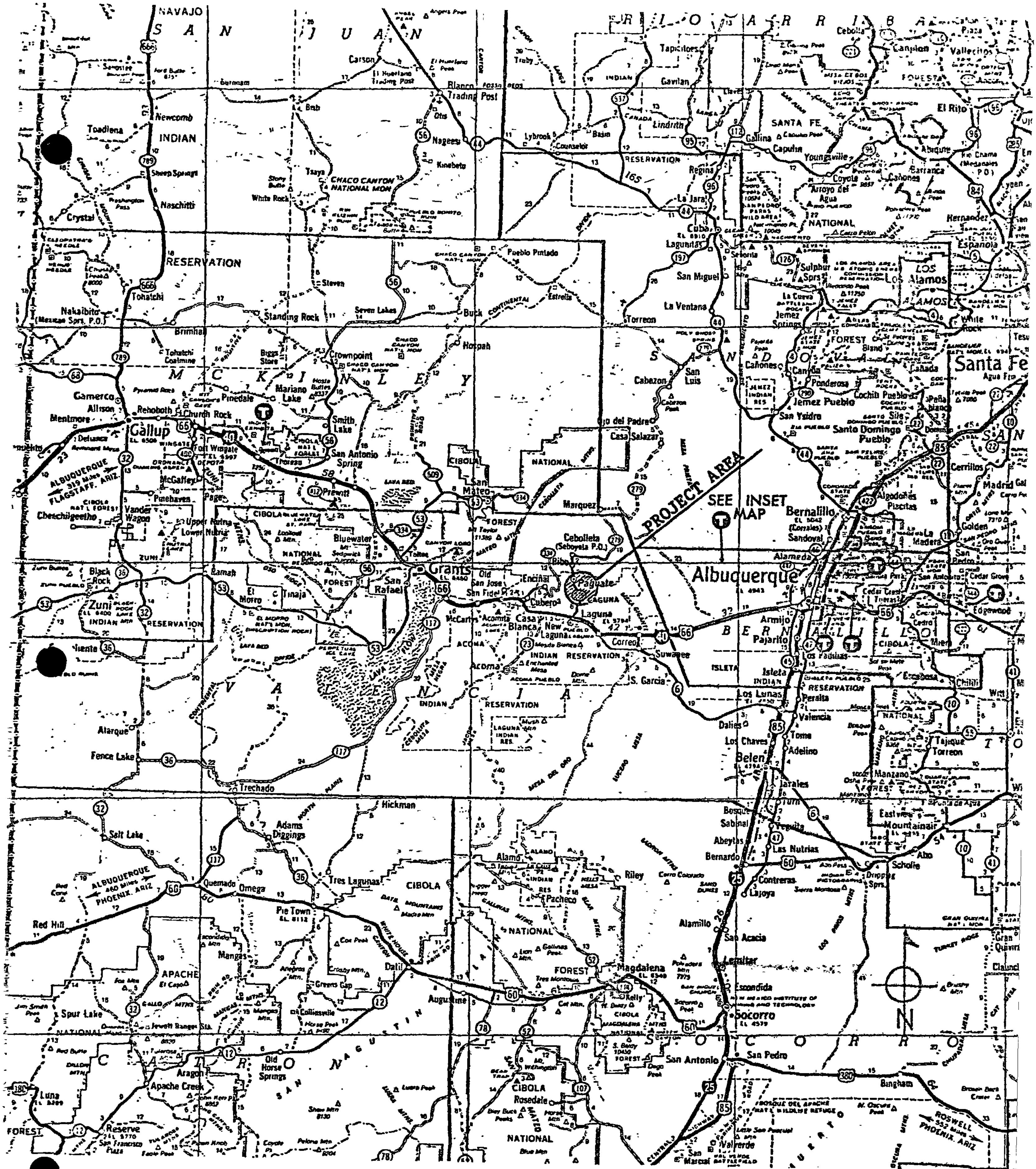
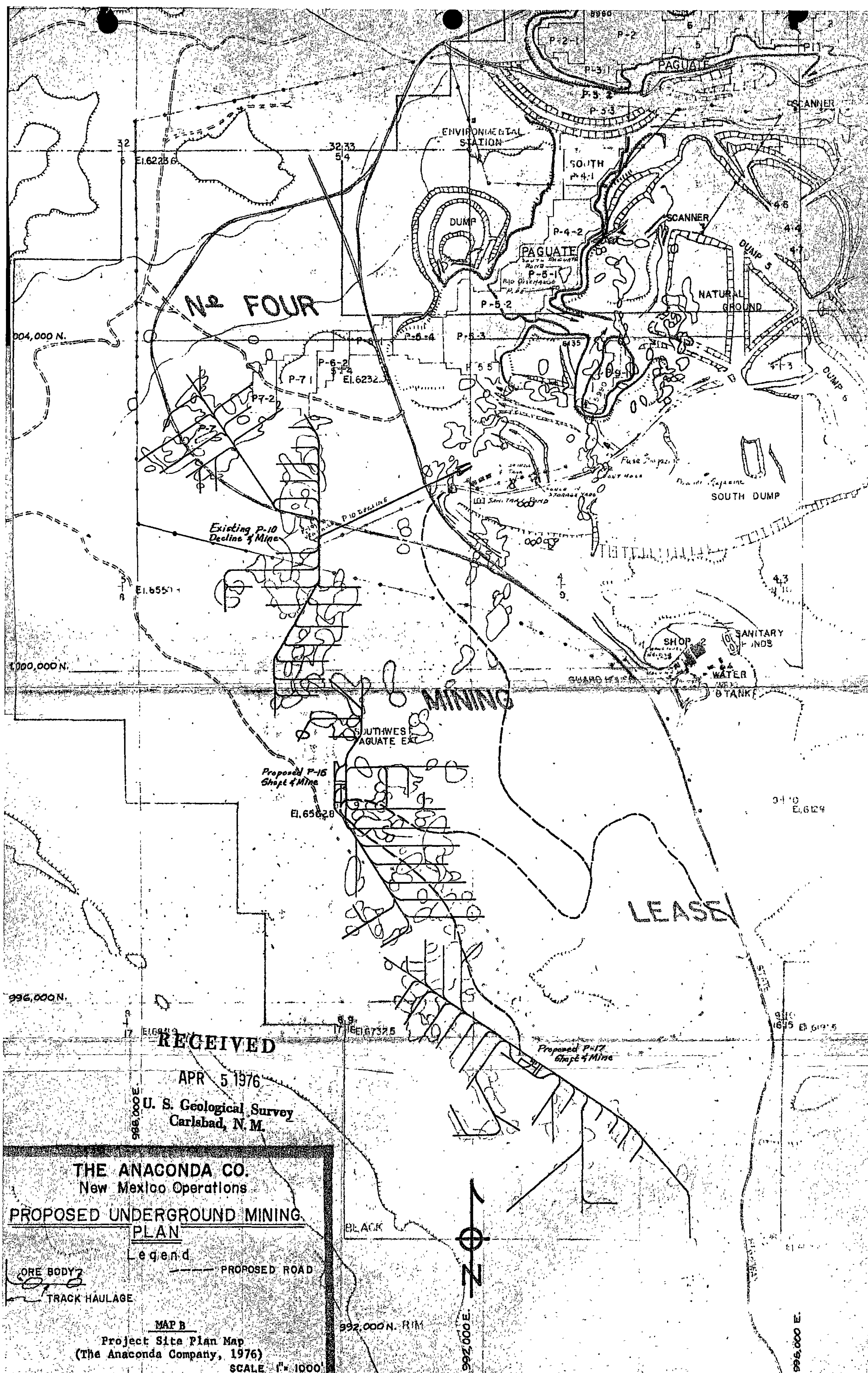
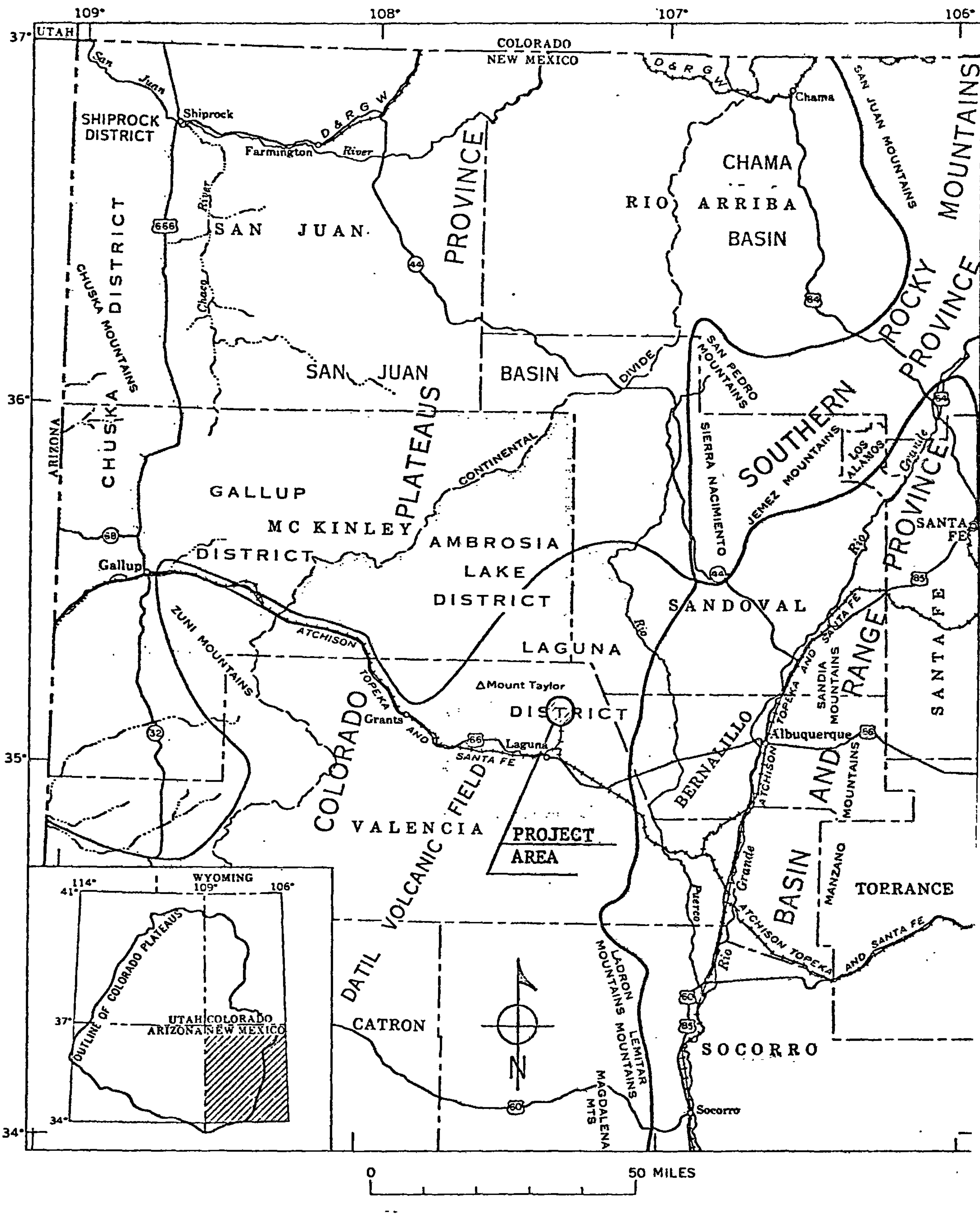
MAPS



MAP A

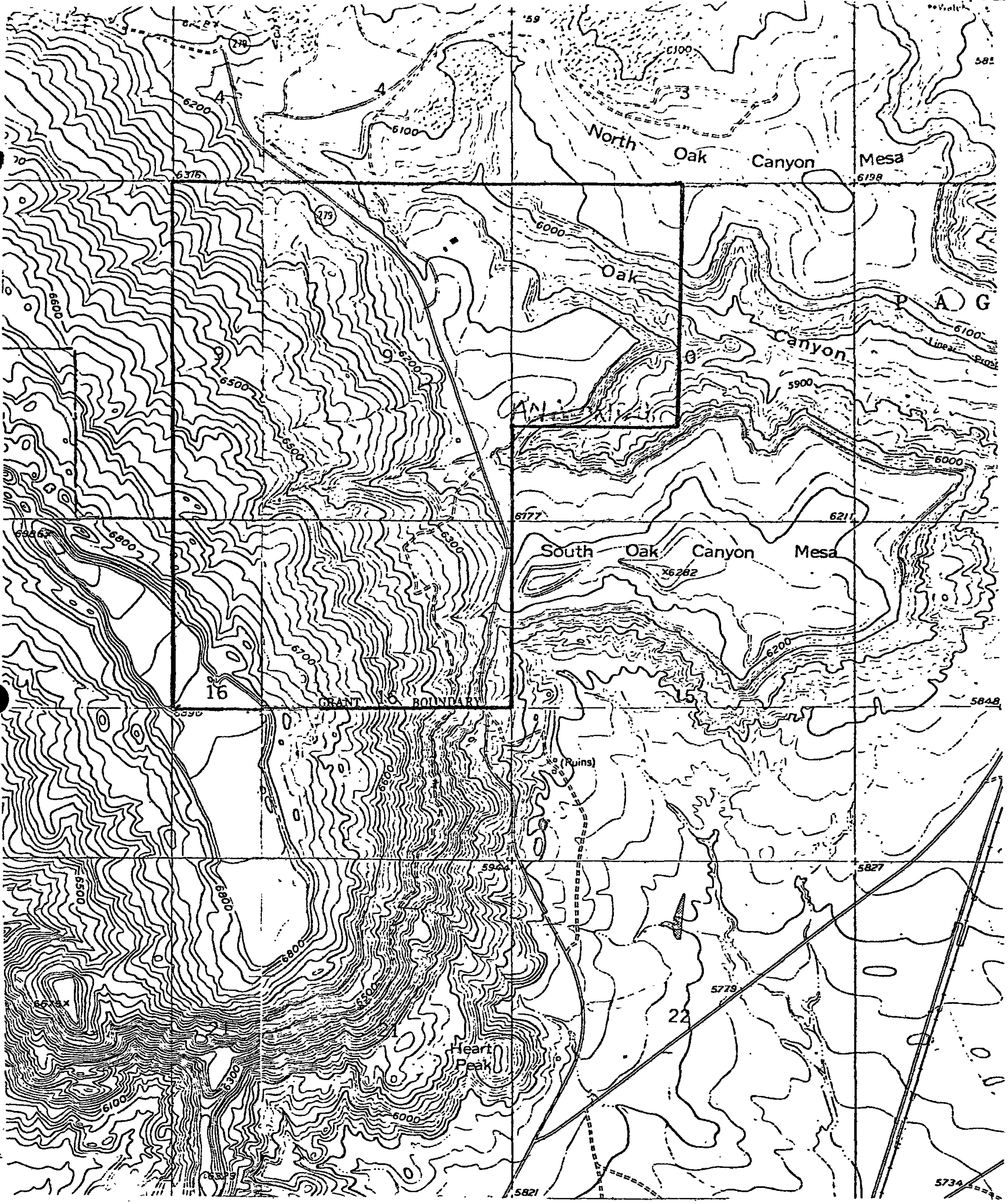
Project Area Location Map
(Texaco Touring Map of New Mexico, 1957)


THE ANACONDA CO.
New Mexico Operations
PROPOSED UNDERGROUND MINING PLAN
Legend
ORE BODY
PROPOSED ROAD
TRACK HAULAGE
MAP B
Project Site Plan Map
(The Anaconda Company, 1976)
SCALE 1"= 1000'
RECEIVED
APR 5 1976
U. S. Geological Survey
Carlsbad, N.M.
No FOUR
MINING
LEASE
PAGUATE
ENVIRONMENTAL STATION
DUMP
SOUTH DUMP
NATURAL GROUND
SCANNER
DUMP 5
DUMP 6
SHOP 2
SANITARY PONDS
WATER WELL & TANK
SOUTHWEST PAGUATE EXT
Existing P-10 Decline & Mine
P-10 DECLINE
Proposed P-16 Shaft & Mine
Proposed P-17 Shaft & Mine
1,004,000 N.
1,000,000 N.
996,000 N.
992,000 N.
988,000 E.
992,000 E.
996,000 E.
El. 6550
El. 6232
El. 6562.8
El. 6737.5
BLACK
RIM



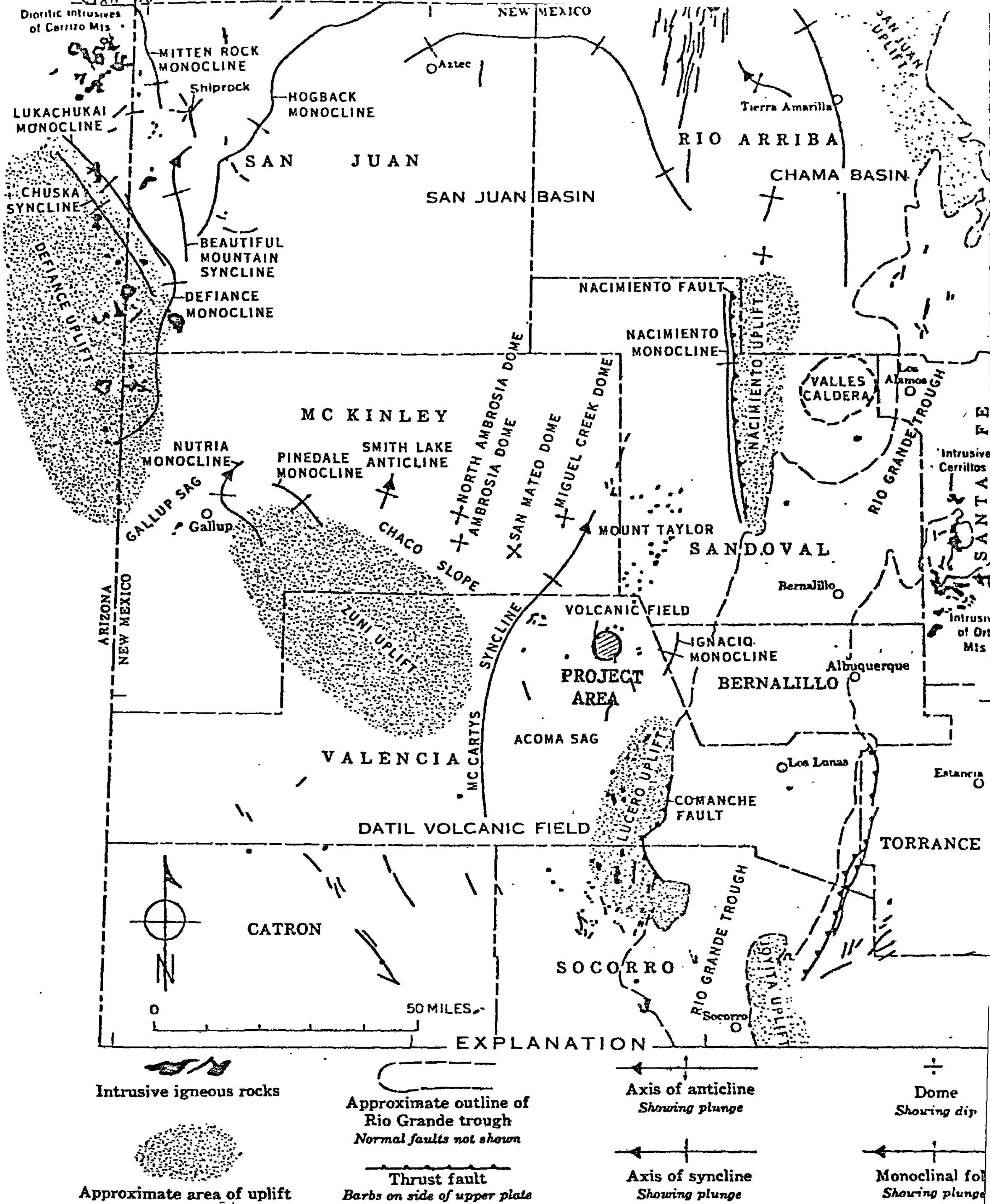
MAP C

Physiographic Map of Northwestern New Mexico
(Hilpert, 1969, p. 3)



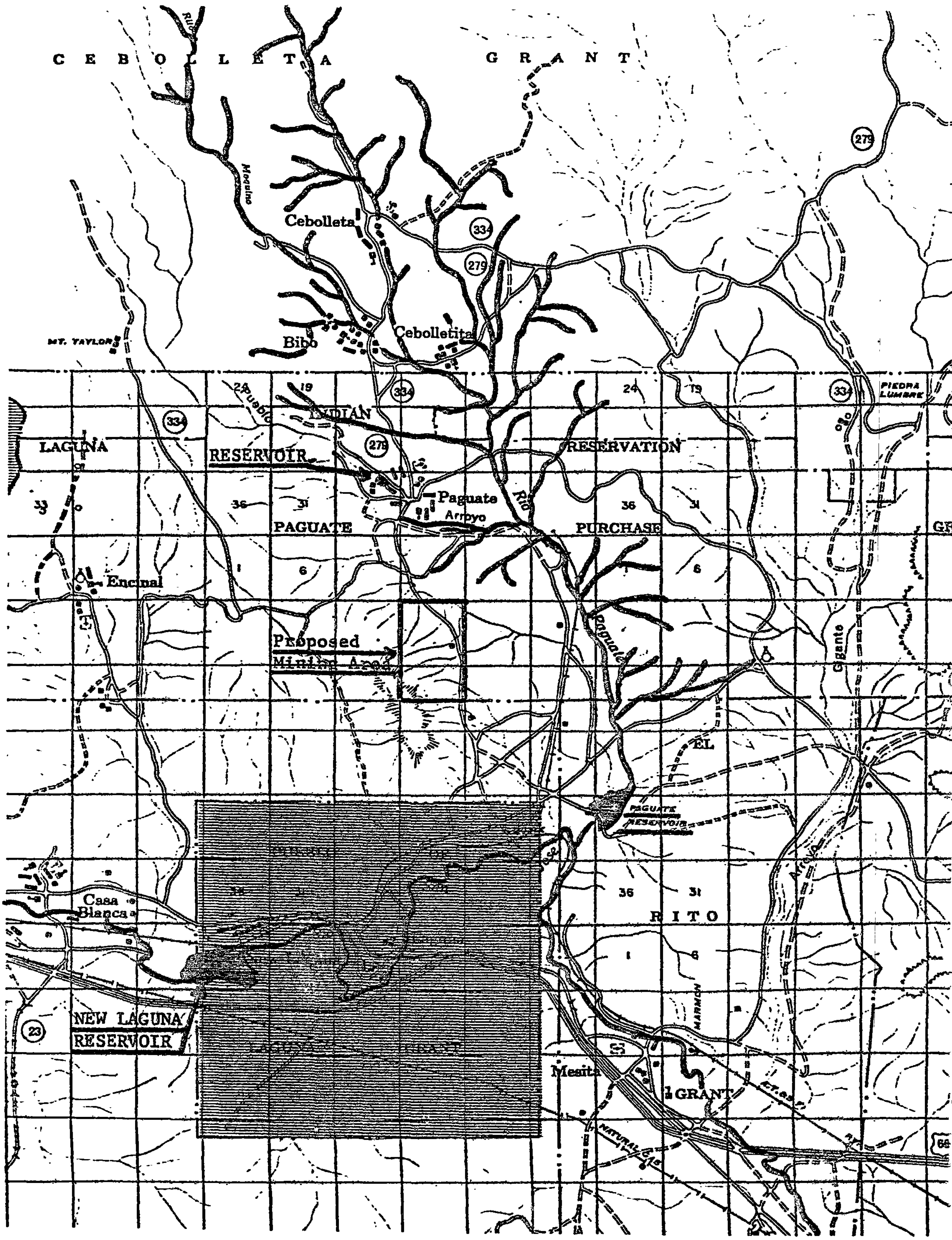
MAP D

Project Area Topographic Map
(USGS 7.5 Minute Series, Laguna and Mesita Quadrangles)



MAP E.

Structural Elements in Northwestern New Mexico
(Hilpert, 1969, p. 27)



MAP F

Surface Water Sources

Scale: ½"=1 mile

(Bureau of Land Management Color Quad Map, 1975, Cubero Quad)

PHOTOGRAPHS

PHOTO A

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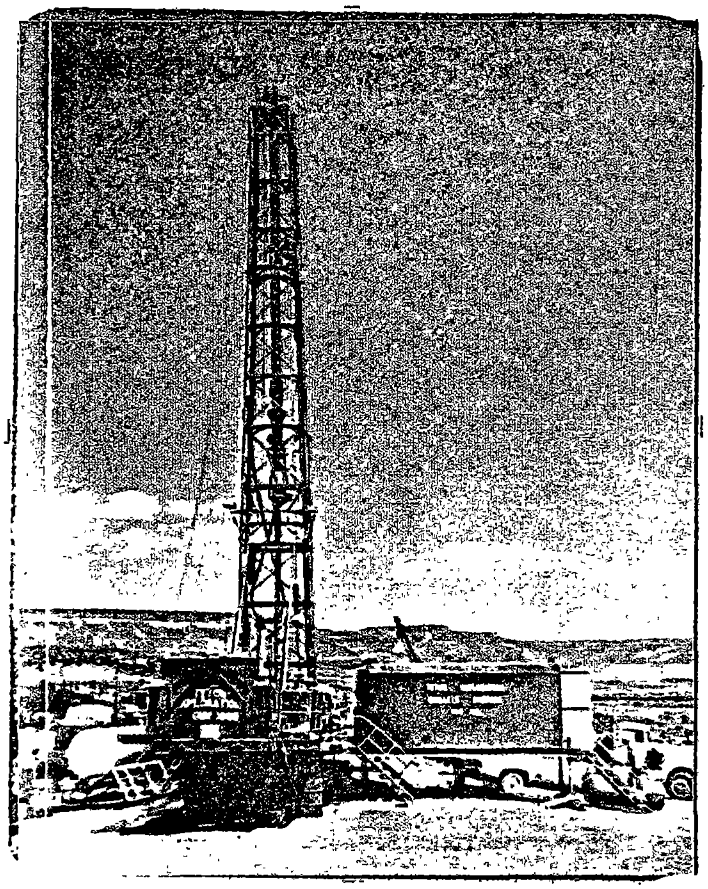

PHOTO B

Surface drilling of ventilation borehole for the P-10 Mine

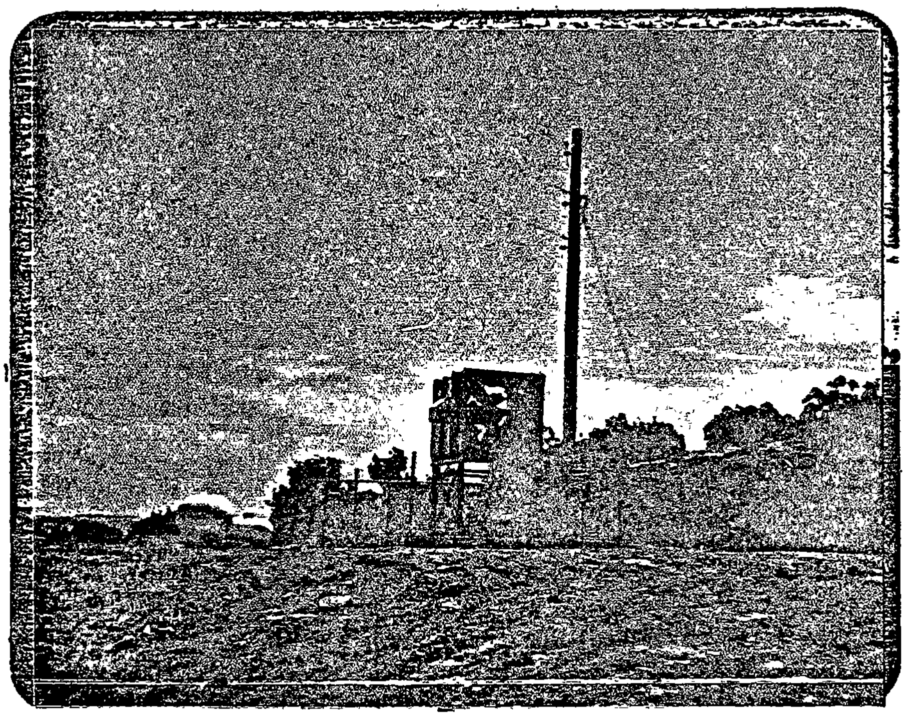

PHOTO C

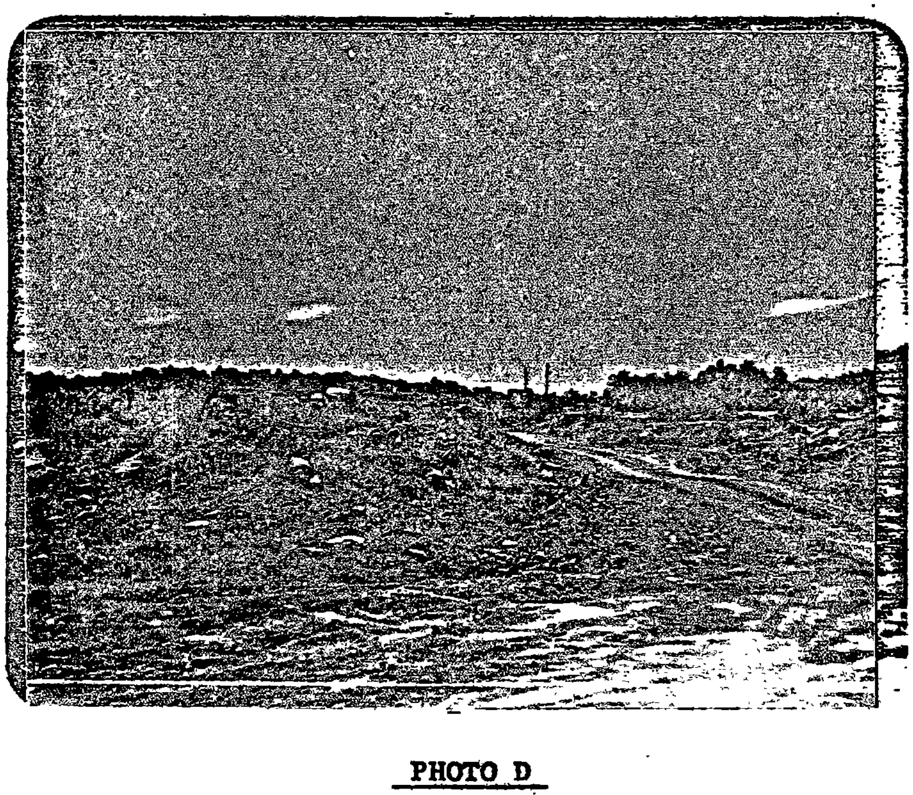

PHOTO D

Surface fan and associated equipment for ventilation borehole for the P-10 Mine; white butane tanks are for heater

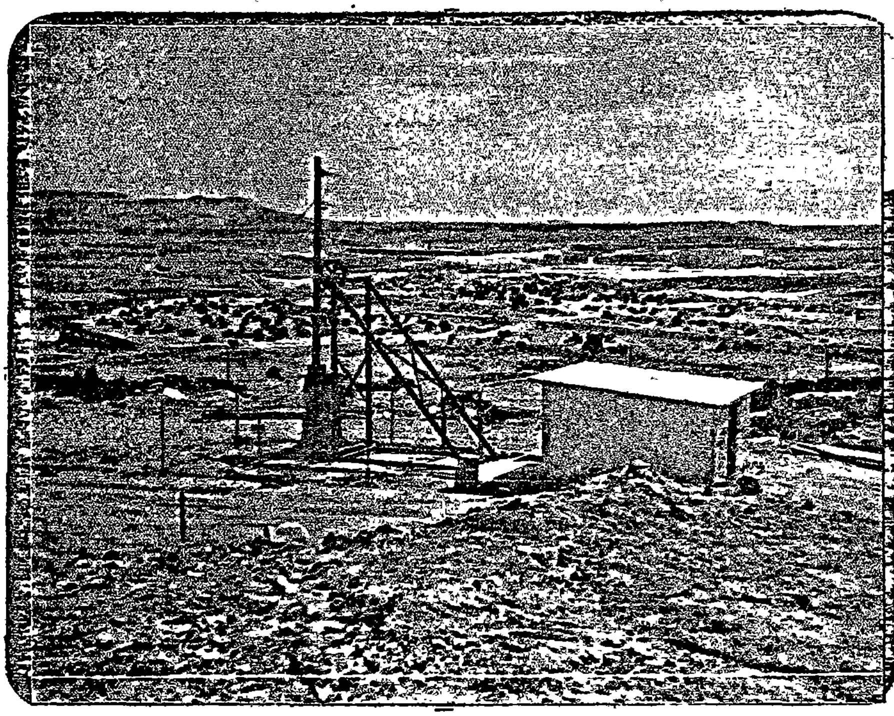

PHOTO E

Emergency hoisting equipment on ventilation borehole at the P-10 Mine; open-pit operations in the background

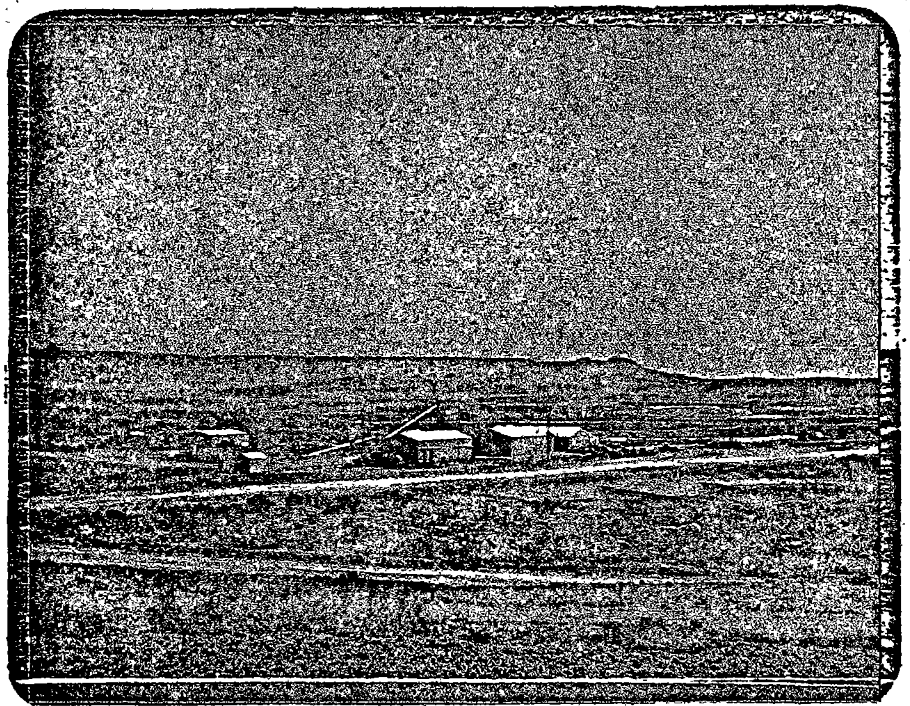

PHOTO F

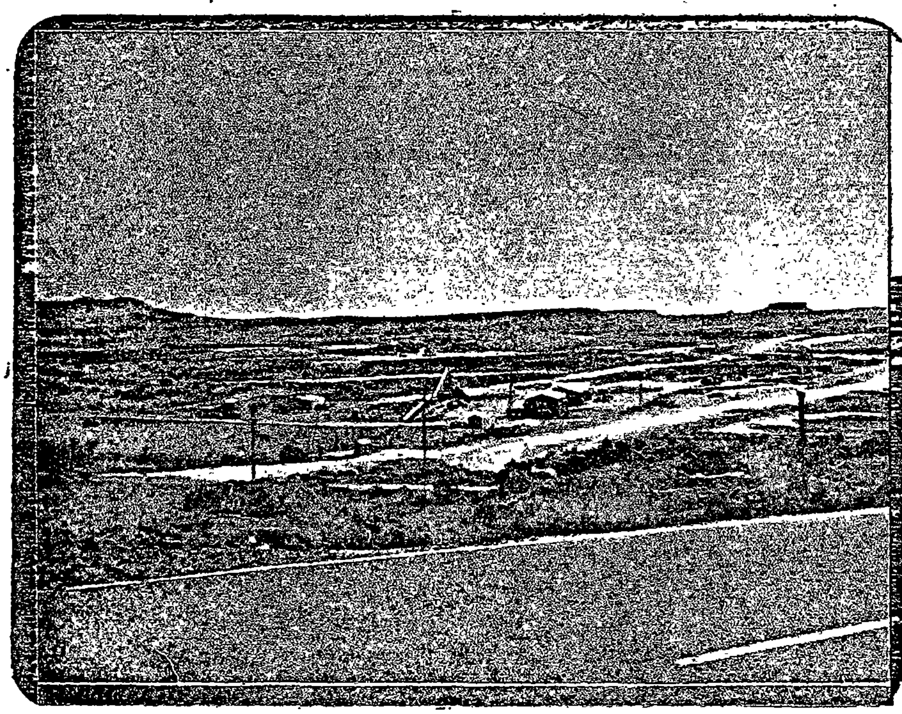

PHOTO G

Surface facilities for the P-10 Mine as seen from State Highway 279

PHOTO H

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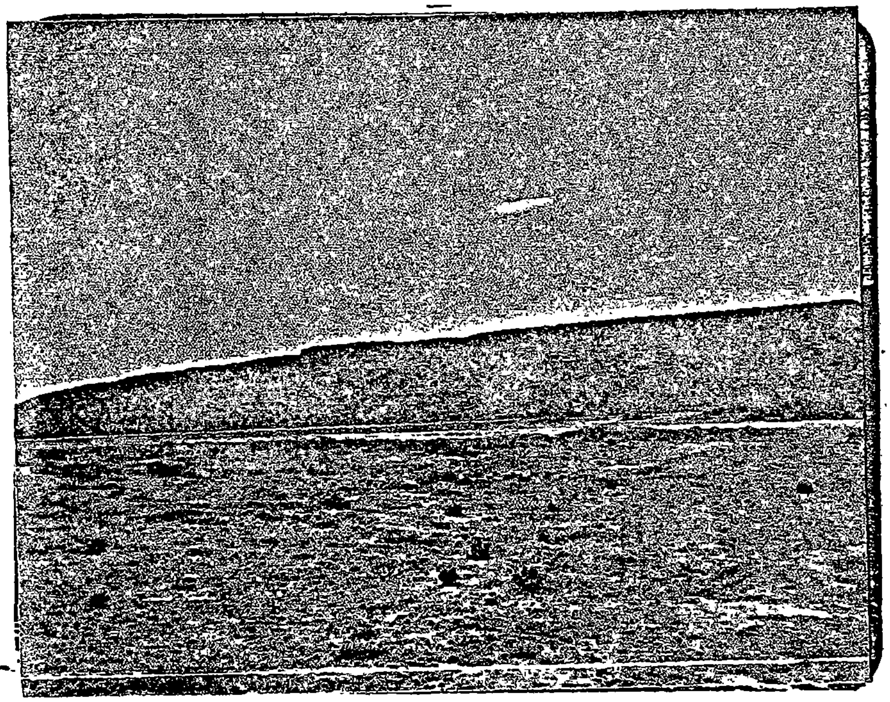

PHOTO I

Northeast flank of Black Rim Mesa looking slightly southwest

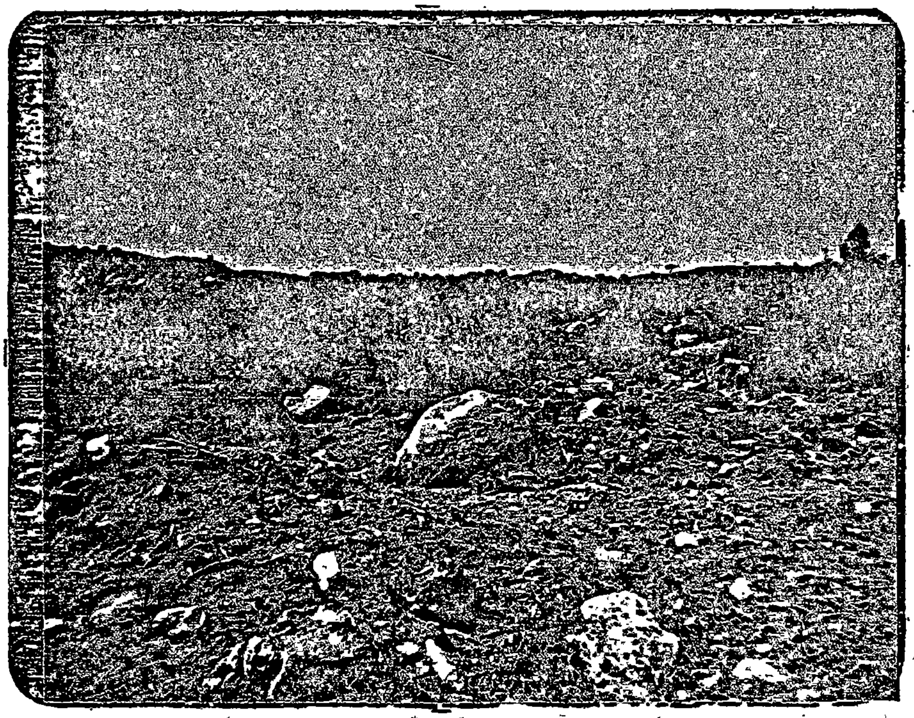

PHOTO J

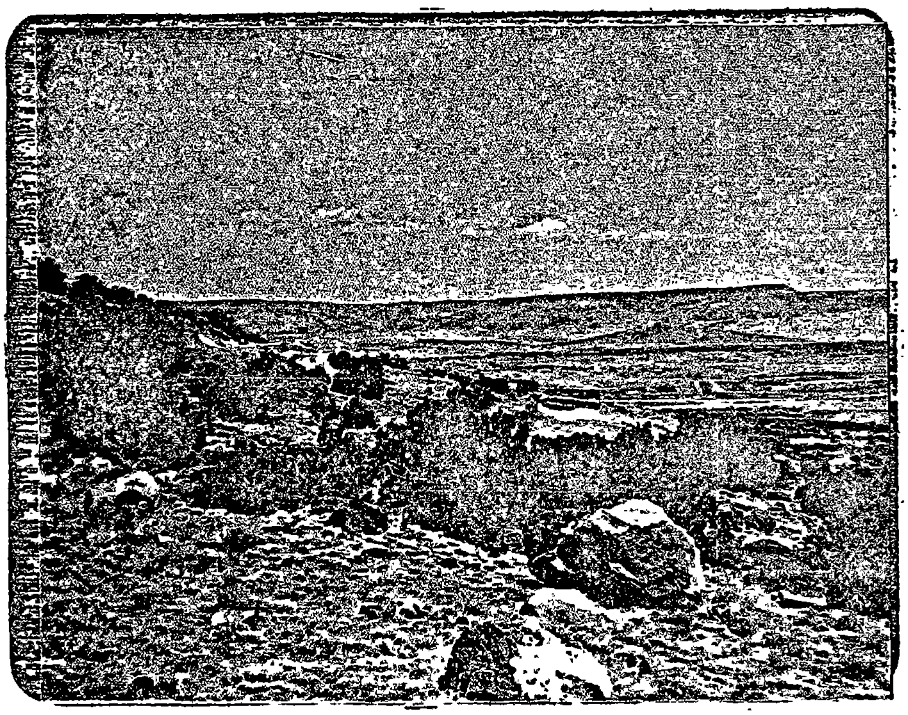

PHOTO K

Terrain and vegetation in the proposed mining area on the northeast flank of Black Rim Mesa

<u>APPENDICES</u>

APPENDIX I

Geologist's Memorandum Report

United States Department of the Interior

GEOLOGICAL SURVEY
P.O. BOX 1716
CARLSBAD, NEW MEXICO 88220

IN REPLY
REFER TO:

March 19, 1976

Memorandum

To: Area Geologist, USGS,
Roswell, New Mexico

From: Area Mining Supervisor, USGS,
Carlsbad, New Mexico

Subject: The Anaconda Company's Proposed Mining and Reclamation Plan for the P-15 and P-17 Mines on Laguna Tribal Lease No. 4

Please review the enclosed copy of the above plan (one volume with map pocket) and return with your report.

Dale C. Jones
Dale C. Jones
Mining Engineer
For Area Mining Supervisor

DCJ:nb

Enclosure:

United States Department of the Interior
GEOLOGICAL SURVEY
P.O. BOX 1716
CARLSBAD, NEW MEXICO 88220

IN REPLY
REFER TO:

May 21, 1976

Memorandum

To: Area Geologist, SRMA, USGS, Roswell, New Mexico

From: Area Mining Supervisor, SRMA, USGS, Carlsbad

Subject: The Anaconda Company's Proposed Mining and Reclamation Plan for the P-15 and P-17 Uranium Mines on Laguna Tribal Lease 4

Copies of the company's addendums to the subject plan are enclosed for your review and reference in preparing a geologic report for the plan. Please return the plan and addendums with your report.

Dale C. Jones
Mining Engineer
for Area Mining Supervisor

DCJ:cj

Enclosures

RECEIVED United States Department of the Interior

JUN 2 1976

U. S. Geological Survey
Carlsbad, N.M.

GEOLOGICAL SURVEY
Drawer 1857
Roswell, New Mexico 88201

June 1, 1976

MEMORANDUM

TO: Area Mining Supervisor, Southern Rocky Mountain Area, Carlsbad, New Mexico

FROM: Pete C. Aguilar, Staff Geologist, Southern Rocky Mountain Area, Roswell, New Mexico

SUBJECT: Geologic review of Mining and Reclamation Plans for Anaconda's P-15 and P-17 uranium mines -- Jackpile-Paguate minesite, Valencia County, New Mexico

The Anaconda Company Uranium Division has submitted mining and reclamation plans pertinent to the development of two new uranium mines P-15 and P-17 in T. 10 N., R. 5 W.

Dale Jones is to be commended for efforts to secure geologic information to add to the original mining and reclamation plans for P-15 and P-17. The proponents of these mining plans do not incorporate appreciable geologic information into their mining plans. Two maps submitted for each minesite are without location markings (township and range etc.). The two stratigraphic columns submitted in addendum do not show location nor are they keyed to the maps previously submitted.

In response to questions asked, the proponent stated the following: (1) foresees no geologic hazards; (2) knows of no recognizable geological structures; (3) Paguate and Jackpile deposits are essentially the same; (4) the ore occurs in tabular lenses with irregular planar outlines and dimensions; (5) lenses vary in thickness from just a few feet to about 20 feet; (6) occassionally are stacked and (7) finds no other minerals.

Pete C. Aguilar

NOTED
D. M. VAN SICKLE

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

APPENDIX II

Stratigraphy

Table 1
(NMEI, 1975, p. 160)

REGIONAL STRATIGRAPHY (unconformities not shown)

Period	Epoch	Stratigraphic Unit
Quaternary	Recent and Pleistocene	San Juan Basin unnamed gravels and alluvium
Tertiary	Pliocene	Chuska Sandstone (700-900) and unnamed fluvial and lacustrine beds
	Eocene	San Juan Fm. (0-3000)
	Paleocene	Nacimiento Fm. (600-1000)
Cretaceous	Late	Ojo Alamo Sandstone (0-400)
		Kirtland Shale (0-1200)
		Fruitland Fm. (0-500)
		Pictured Cliffs Sandstone (70-400)
		Lewis Shale (0-2000)
		Mesaverde Group
		Cliff House Sandstone (100-1000)
		Menefee Fm. (0-2000)
		Point Lookout Sandstone (250-350)
		Crevasse Canyon Fm. (500-750)
		Gallup Sandstone (0-250)
		Mancos Shale (300-2000)
		Dakota Sandstone (0-200), possibly some Early Cretaceous
Jurassic	Late	Morrison Fm.
		Brushy Basin Member (0-600)
		Westwater Canyon Member (0-300)
		Recapture Member (0-500)
		San Rafael Group
		Cow Springs Sandstone (Bluff Sandstone) (0-350)
		Summerville Fm. (50-225)
		Todilto Limestone (0-100)
		Entrada Sandstone (0-300)
Triassic	Late	Wingate Sandstone (0-65)
		Chinle Fm. (0-1600)
	Middle (?) Early	Moenkopi (?) Fm. (0-200)
Permian		San Andres Limestone (0-125)
		Glorieta Sandstone (100-200)
		Yeso Fm. (500-750)
		Madera Limestone
Precambrian		Igneous and metamorphic rocks

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U. S. Geological Survey
Carlsbad, N.M.

P-15 AREA - TYPICAL STRATIGRAPHIC SECTION

(The Anaconda Company, 1976)

0-20'	Colluvium, containing slump block basaltic material from remnants of Wheat Mountain to the west.
20-458'	Cretaceous, undifferentiated. Marine sandstones grading downward into shales. Sandstone units are capped by a few feet of fairly hard, silica cemented sandstone.
458-496'	Lower Cretaceous, Basal Dakota sandstone. Its base is a hard, fine-to-medium grained, sugary textured, rounded to sub-rounded sandstone (± 10') that grades abruptly upward into fairly soft carbonaceous and shaly siltstone. Lies unconformably on the Jurassic sediments.
496-600'	Jurassic, Jackpile sandstone member of Brushy Basin. Locally ± 100'. Generally gray to buff, medium grained, friable, massive sandstone. Quite kaolinitic, locally contains stringers, blebs and thin beds of gray-green mudstone. Mineralization in this area generally in the top third of the unit.
600-	Jurassic, Brushy Basin shale member. Generally near upper contact, calcareous green shales, mudstones and interbedded gray-green limestones, locally with recrystallized calcite.

P-17 AREA - TYPICAL STRATIGRAPHIC SECTION

(The Anaconda Company, 1976)

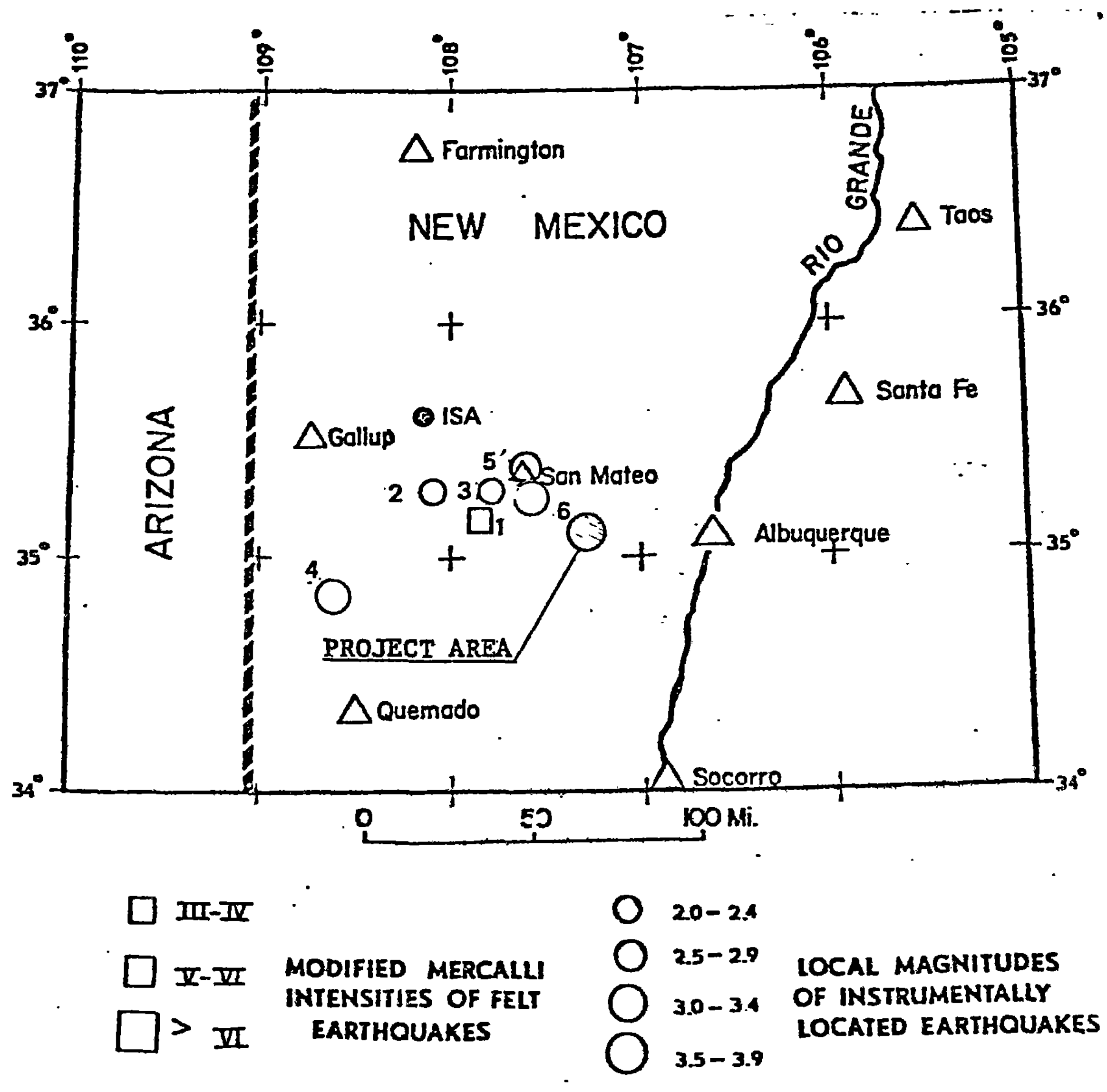
0-50'	Colluvium, containing blocks of basalt from remnants of Wheat Mountain to the west.
50-520'	Cretaceous, undifferentiated. Marine sandstones grading downward into shales. Sandstone units are capped by a few feet of fairly hard, silica and calcite cemented sandstone.
520-554'	Lower Cretaceous, Basal Dakota sandstone. Its base is a hard, fine-to-medium grained, sugary textured, rounded to sub-rounded sandstone (± 10') unit that grades abruptly upward into fairly soft carbonaceous and shaly siltstone. Lies unconformably on the Jurassic sediments.
554-648'	Jurassic, Jackpile sandstone member of Brushy Basin. Locally ± 95'. Generally gray to buff, medium grained, friable, massive sandstone. Quite kaolinitic, locally contain stringers, blebs and thin beds of gray-green mudstone. Near the base of the section the mudstones are intimately mixed with the sandstone, making selection of the Brushy Basin contact difficult. Mineralization in this area generally in the top third of the unit.
648-	Jurassic, Brushy Basin shale member. Generally near upper contact, calcareous green shales, mudstones and interbedded gray-green limestone, locally with recrystallized calcite.

APPENDIX III

Seismic Data

Figure 1

Locations of felt earthquakes and instrumental epicenters within 60 miles of Mariano Lake. Numbers correspond to event numbers in Tables 1 and 2 (NMEI, 1975, p. 171).



<u>Table 1</u>

Earthquakes felt within 60 miles of Mariano Lake prior to 1962 (NMEI, 1975, p. 170).

No.[Δ]	Yr	Mo	Day	Time GMT[+]	Location of Max. Reported Intensity	Maxium Reported Intensity[†]
1	1940	May	17	05.10	Grants	(III)

* From U. S. Dept. of Commerce, NOAA, ERD U. S. Earthquakes. Prepared annually, it lists epicenters and associated phenomena of all earthquakes recorded or reported in the United States.

Δ Number corresponds to earthquake location number shown in Figure 5-6.

+ Greenwich Mean Time

† Modified Mercalli Intensity Scale of 1931 (see Appendix D).

Table 2

Instrumentally located earthquakes within 60 miles of Mariano Lake January 1962, through April 1974 (NMEI, 1975, p. 173).

No.†	Date Yr Mo Day	Origin Time GMT*	Location Lat°N	Location Long°W	Magnitude** m_b	Magnitude** M_L	References+
2	1963 Aug. 21	00:23:21.2	35.3	108.1		2.0	(1)
3	1963 Aug. 27	05:18:17.0	35.3	107.8		2.3	(1)
4	1969 Aug. 23	21:41:54.2	34.8	108.7		3.0	(3)
5	1971 May 22	22:31:19.8	35.4	107.6		2.8	(3)
6	1973 Dec. 24	02:20:14.9	35.3	107.7	4.4	4.1	(2)

† Numbers correspond to earthquake location numbers shown in Figure 5-6.

* Greenwich Mean Time.

** m_b is reported by U. S. G. S. (Earthquake Data Report); M_L was calculated by New Mexico Institute of Mining and Technology, Socorro, New Mexico, using seismograms from stations at Albuquerque and Socorro.

\+ Numbers in this column refer to the following sources:
(1) Sanford, 1965; (2) U. S. Dept. of Interior, USGS, ERL; (3) Toppozada and Sanford, 1972.

Figure 2

Locations of felt earthquakes and instrumental epicenters in the vicinity of Mount Taylor. Numbers correspond to event numbers in Tables 3 and 4 (NMEI, 1974, p. 87).

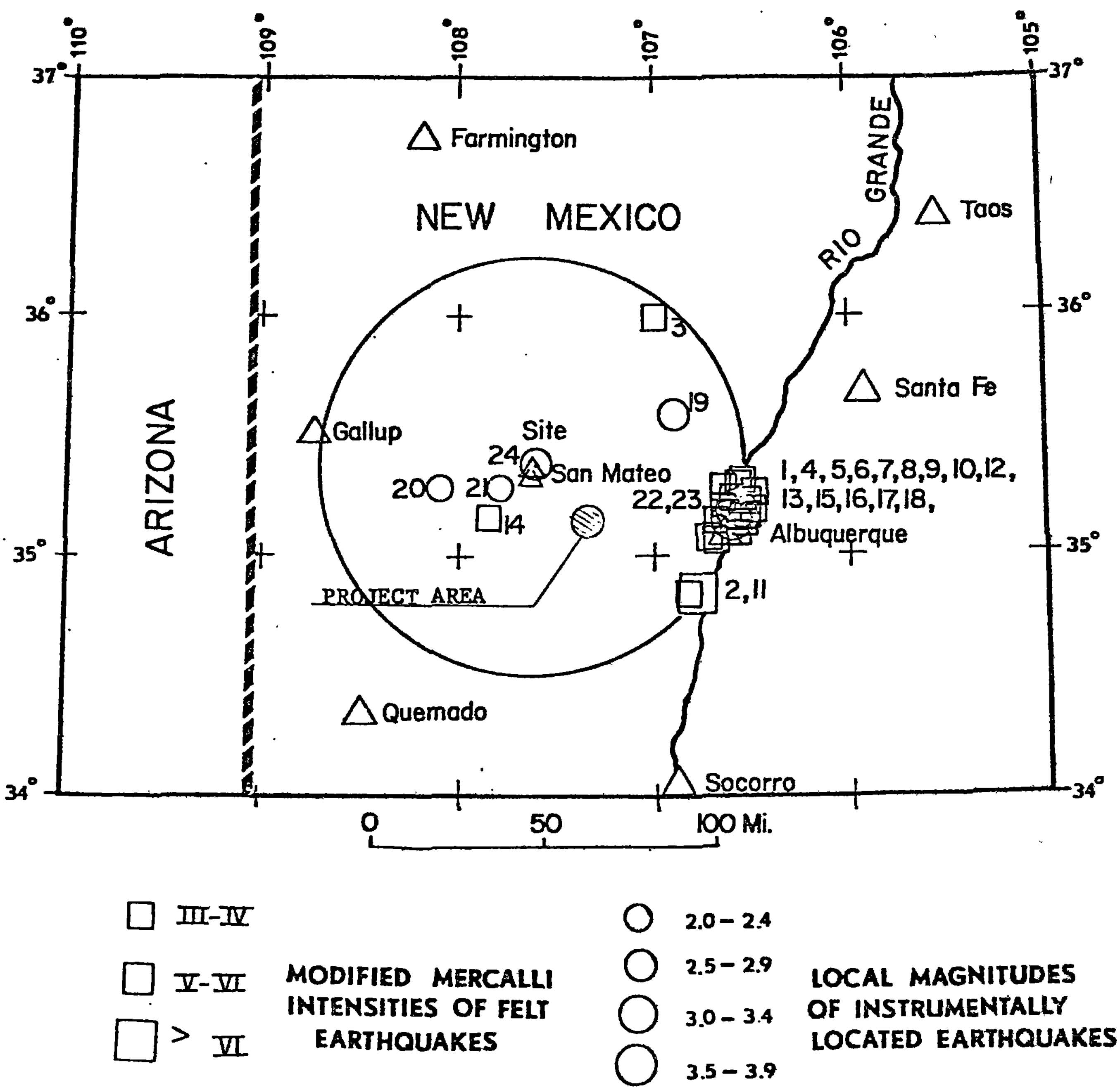


Table 3

Earthquakes felt in the vicinity of Mount Taylor prior to 1962 (NMEI, 1974, p. 88).

No.	Yr Mo Day	Time GMT[▼]	Location of Max. Reported Intensity	Maximum Reported Intensity*	References+	Remarks
1	1893 July 12	13:00 to 14:00	Albuquerque	V	(1),(2)	Three shocks.
2	1893 Sept. 7		Los Lunas	VII	(1),(2)	Strongest shock of a 3 month long swarm.
3	1921 July 31	03:55	Senorito	IV	(2)	
4	1930 Mar. 23	19:00	Albuquerque	(III-IV)	(3)	
5	1930 Dec. 3	21:36	Albuquerque	(IV)	(3)	Two distinct shocks.
6	1930 Dec. 4	22:30	Albuquerque	(III)	(3)	Aftershock of Dec. 3.
7	1931 Jan. 27		Albuquerque	(III)	(3)	
8	1931 Feb. 3	23:45	Albuquerque	V	(4)	
9	1931 Feb. 5	04:48	Albuquerque	VI	(3)	Hundreds left houses. Goods thrown from several stores, shelves.
10	1936 Sept. 9	12:55	Albuquerque	(III)	(3)	Two weak shocks.
11	1938 Mar. 23	06:00	Los Lunas	(III)	(3)	
12	1938 Apr. 15	21:00	Albuquerque	(III)	(3)	
13	1938 Apr. 16	08:15	Albuquerque	(III)	(3)	
14	1940 May 17	05.10	Grants	(III)	(3)	
15	1947 Nov. 6	16:50	San Antonito	(V-VI)	(3)	Felt in 10 mi. radius
16	1954 Nov. 2	17:00	Albuquerque	(IV)	(3)	Felt 20 mi. NS direction.
17	1954 Nov. 3	20:39	Albuquerque	V	(3)	Felt 20 mi. NS direction.
18	1956 Apr. 26	03:30	Sandia Mtns.	V	(3)	

▼Greenwich Mean Time.

*Modified Mercalli Intensity Scale of 1931 (see Appendix A). Intensity values assigned by the author are given in parentheses.

+Numbers given in this column are for the references from literature cited listed below: (1) Eppley, 1956; (2) Woollard, 1968; (3) U.S. Earthquakes (a U. S. Dept. of Commerce publication prepared annually that lists epicenters and associated phenomena of all earthquakes recorded or reported in the United States); (4) personal communications, S. A. Northrop, 1972.

Table 4

Instrumentally located earthquakes in the vicinity of Mount Taylor January 1962, through June 1971 (NMEI, 1974, p. 90).

No.	Date Yr Mo Day	Origin Time GMT$^{\Psi}$	Location Lat $^{\circ}$N	 Long $^{\circ}$W	Magnitude* m_b	 M_L	References+
19	1962 June 14	07:27:55.8	35.6	106.9		2.8	(1)
20	1963 Aug. 21	00:23:21.2	35.3	108.1		2.0	(1)
21	1963 Aug. 27	05:18:17.0	35.3	107.8		2.3	(1)
22	1970 Nov. 28	07:40:11.6	35.0	106.7	4.5	3.5	(2)
23	1971 Jan. 4	07:39:06.7	35.0	106.7	4.7	3.8	(2)
24	1971 May 22	22:31:19.8	35.4	107.6		2.8	(3)

$^{\Psi}$Greenwich Mountain Time.

*m_b is reported by U.S. Dept. Commerce (Earthquake Data Report); M_L was calculated by New Mexico Institute Mining and Technology, Socorro, New Mexico, using seismograms from stations at Albuquerque and Socorro.

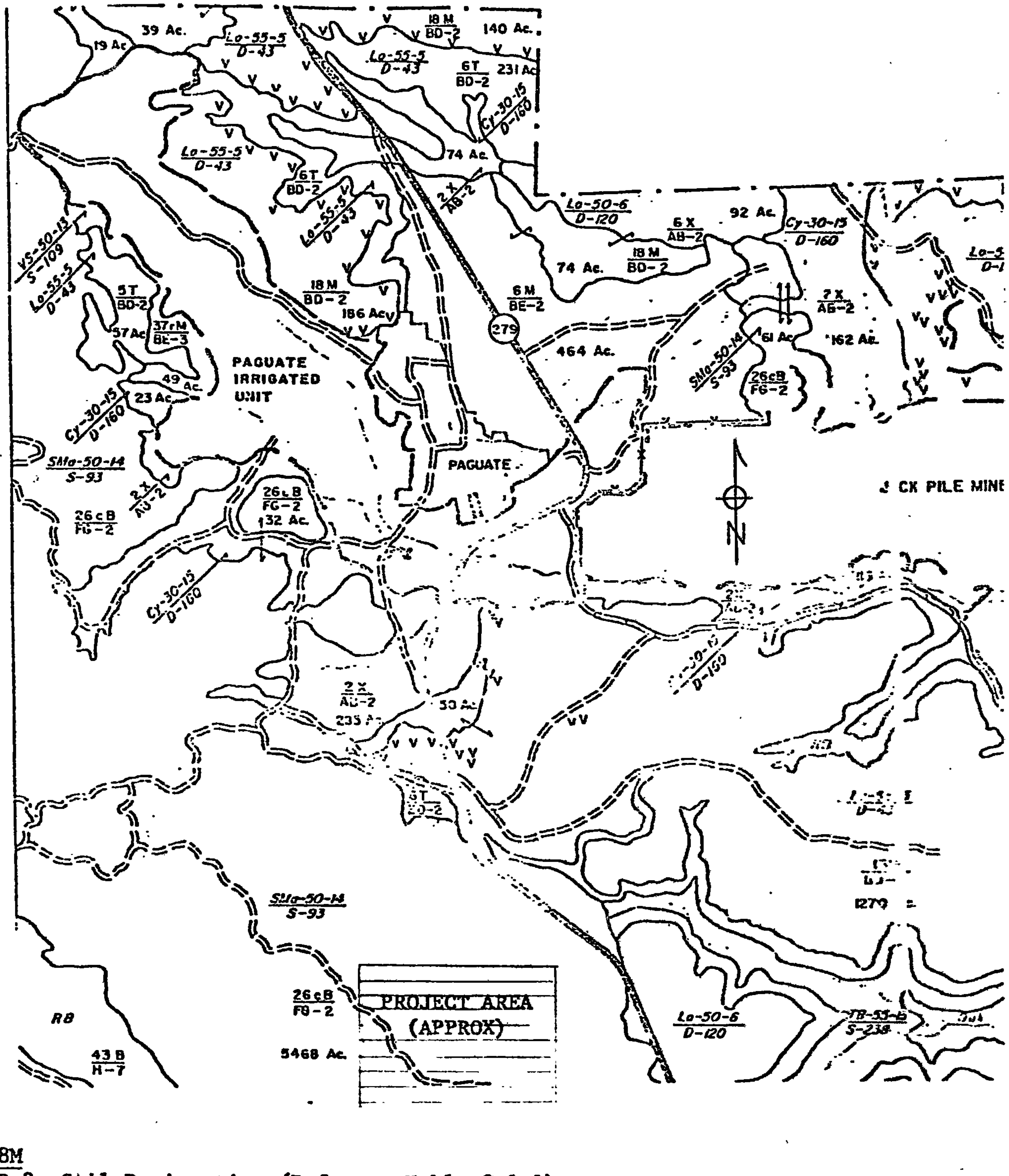
+Numbers in this column are for the references from literature cited listed below: (1) Sanford, 1965; (2) U.S. Dept. of Commerce, Earthquake Data Report, ERL; (3) Toppoz

APPENDIX IV

Soils in the Vicinity of the Jackpile-Paguate Mine

Soils in the Vicinity of Jackpile-Paguate Mine

(The Anaconda Company, 1976)



18M
BD-2 Soil Designation (Refer to Table 2.1-1)
-- Extent of Mine Disturbance at Time of Soil Mapping

TABLE 2.1-1

MAP SYMBOLS AND DESCRIPTION FOR SOILS APPEARING ON PLATE 2.1-1

(The Anaconda Company, 1976)

Map Symbol	Soil Description
2X / AB-2	A deep, fine textured, slowly permeable, moderately eroded soil formed from recently deposited alluvial soil materials of mixed origin, occurring on nearly level to gently sloping (0-3%) flood plains.
5T / BD-2	A deep, medium textured, slowly permeable, moderately eroded soil formed from outwash soil material of mixed origin moved and deposited by flood waters from higher slopes and occurs on gentle to strong (1-8%) slopes.
6T / BD-2	A deep, medium textured, moderately permeable, moderately eroded soil formed from soil material of mixed origin, moved and deposited by flood waters from higher slopes. This soil mapping unit is widely scattered within the Morrison geolgoical formation and is usually found below sandstone bluffs or ridges. It occurs on gentle to strong (1-8%) slopes.
6M / BE-2	A deep, medium textured, moderately permeable, moderately eroded soil formed from sandstone. It occurs on gentle to slightly steep (1-12%) slopes. This mapping unit is found in the Morrison, Chinle, and Mancos shale geological formation. It occupies approximately one-half of the mesa top north of Bell Rock and is associated with the Tres Hermanos sandstone formation.
10M / BD-3	A deep, coarse textured, moderately permeable, severely eroded soil developed from sandstone, and occurring on gentle to strong (1-8%) slopes. This soil mapping unit is of major importance and was found within the Morrison and Mancos shale geological formation.
10T / BD-3	A deep, coarse textured, moderately permeable, severely eroded soil formed from outwash soil material of mixed origin, moved and deposited by flood waters from higher slopes. This soil occurs on gentle to strong (1-8%) slopes. This soil mapping unit is of major importance and occurs primarily within the Morrison geological formation.

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Carlsbad, N.M.

TABLE 2.1-1 (Cont'd)

Map Symbol	Soil Description
18M / BD-2	A moderately deep, medium textured, moderately permeable, moderately eroded soil developed from sandstone and found commonly on mesa tops. It occurs on gentle to strong (1-8%) slopes.
26cB / FG-2	A shallow, fine textured, slowly permeable, moderately eroded soil developed from basic igneous (basalt) rock. It occurs on moderately steep to steep (12-55%) slopes.
30M / BE-3	A shallow, medium textured, moderately permeable, severely eroded soil developed from sandstone and occurring on gentle to slightly steep (1-12%) slopes.
37rM / BE-3	A very shallow, medium textured, severely eroded soil which is commonly found on gentle to slightly steep (1-12%) slopes. This mapping unit consists of very shallow sandstone soils with bedrock usually occurring between 4 and 10 inches and is most frequently found near the rim of mesas. Exposed outcroppings of sandstone bedrock are common and may occupy as much as one-third of the area delineated.
43M / H-7	This mapping unit normally occurs as vertical sandstone bluffs on the rims of large mesas. It can be generally described as a miscellaneous land type. It is characteristic of the unit to have very steep (55%+) slopes, to have miscalleanous textures, and variable soil depths with undifferentiated erosion. It has sufficient usable soil material to provide some cover and forage for wildlife. Extensive areas of exposed sandstone bedrock and large boulders are common.

APPENDIX V

Meteorological Data

<u>Figure 1</u>

Average annual precipitation patterns over New Mexico.
Isohyet interval is 2 inches (NMEI, 1974, p. 96).

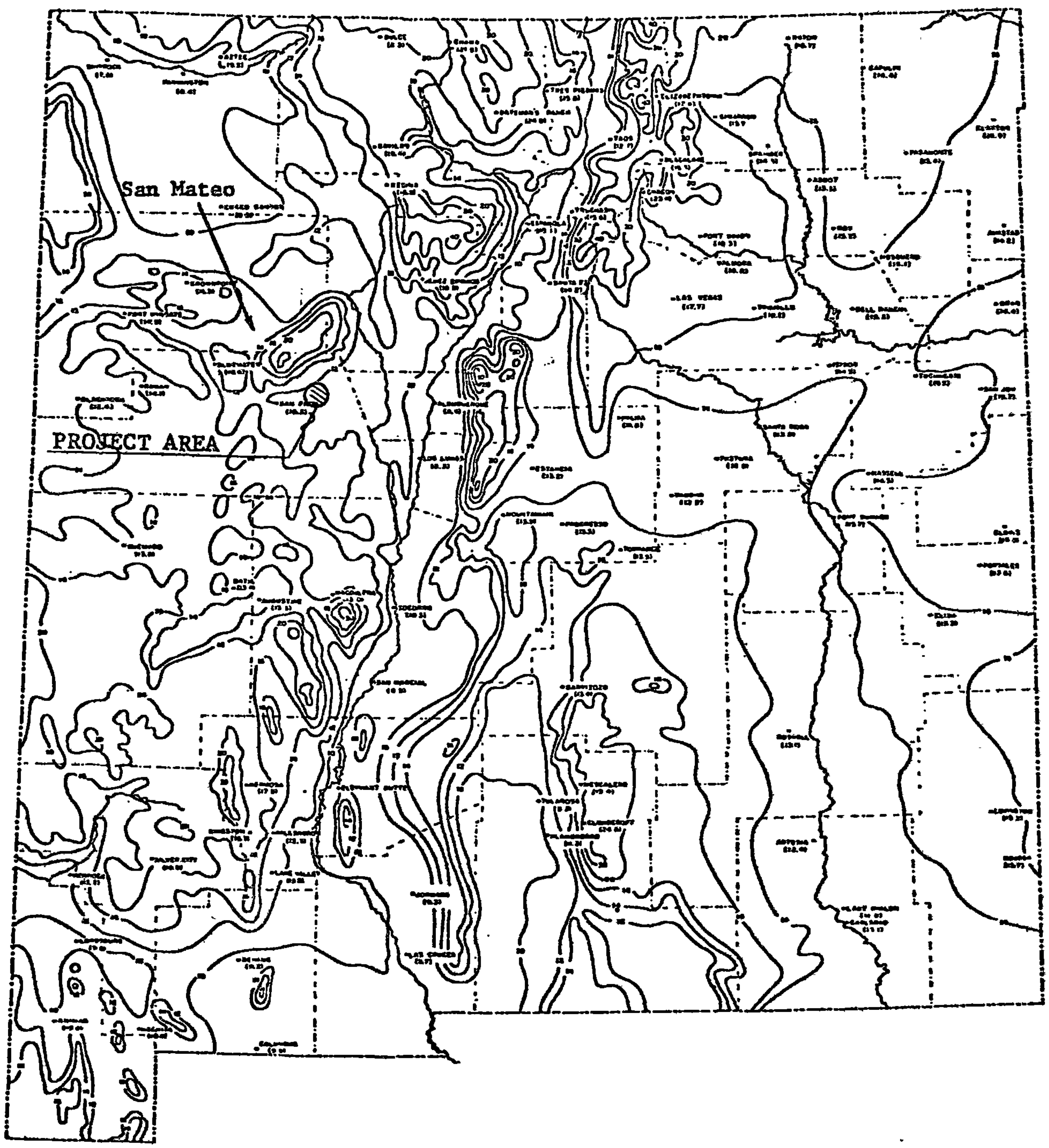


Table 1

Mean precipitation (inches) for stations in the Mount Taylor area (NMEI, 1974, p. 36).

Month	San Mateo* (7250 ft elev.) 1966-1973	San Mateo* (7250 ft elev.) Sept. 1972-Aug. 1973	Grants+ (6480 ft elev.) 1946-1960	San Fidel^Ψ (6160 ft elev.) 1920-1954
Jan.	0.07	0.11	0.36	0.37
Feb.	0.09	0.12	0.39	0.46
Mar.	0.16	0.24	0.45	0.44
Apr.	0.16	0.09	0.36	0.65
May	0.36	0.36	0.43	0.79
June	0.75	1.19	0.69	0.79
July	1.98	2.83	1.81	1.65
Aug.	2.39	1.35	2.18	2.02
Sept.	1.31	1.81	1.17	1.43
Oct.	0.89	3.00	1.07	0.61
Nov.	0.24	0.12	0.33	0.41
Dec.	0.41	0.16	0.62	0.47
Annual	8.81	11.38	10.04	10.09

*Source: U.S. Dept. of Commerce, Environmental Data Service, NOAA, 1973.

+Source: U.S. Forest Service, 1973.

ΨSource: U.S. Dept. of Commerce, Weather Bureau, 1959.

Table 2

Four year summary of wind directions and speed at the Langmuir Laboratory, Socorro, New Mexico (NMEI, 1974, p. 44).

Season	Mean Direction	Mean Speed (mph)
Spring	West-southwest	8
Summer	South-southwest	6
Fall	Southwest	9
Winter	West-northwest	11

APPENDIX VI

Air Quality Regulations, Standards, and Data

Environmental Improvement Agency
STATE OF NEW MEXICO
HEALTH SAFETY WELLBEING COMFORT
P.O. Box 2348, Santa Fe, New Mexico 87503

AIR QUALITY DIVISION

RECEIVED
JUN 1 1976
U. S. Geological Survey
Carlsbad, N.M.

May 26, 1976

Mr. Dale Jones
USGS
Conservation Division
P.O. Box 1716
Carlsbad, New Mexico 88220

Dear Mr. Jones:

Enclosed is the data you requested for the Grants, New Mexico area. If you have any questions, or require any other assistance please feel free to contact me at 827-5271--extention 359 in Santa Fe.

Sincerely,

Martin J. Rinaldi
Program Manager
Monitoring and Surveillance Section

MJR:elc
Enclosure

Federal Register

...dix A—Reference Method for the Determination of Sulfur Dioxide in the Atmosphere (Pararosaniline Method).
...dix B—Reference Method for the Determination of Suspended Particulates in the Atmosphere (High Volume Method).
...dix C—Reference Method for the Continuous Measurement of Carbon monoxide in the Atmosphere (Nondispersive Infrared Spectrometry).
...dix D—Reference Method for the Measurement of Photochemical Oxidants Corrected for Interferences Due to Nitrogen Oxide and Sulfur Dioxide.
...dix E—Reference Method for the Determination of Hydrocarbons Corrected for Methane.
...dix F—Reference Method for the Determination of Nitrogen Dioxide (24-Hour Sampling Method).

...THORITY: The provisions of this Part ...ssued under sec. 4, Public Law 91-604, ... 1679.

...0.1 Definitions.

...) As used in this part, all terms not ...ned herein shall have the meaning ...n them by the Act.

...) "Act" means the Clean Air Act, as ...nded (Public Law 91-604; 84 Stat. ...).

...) "Agency" means the Environmental Protection Agency.

...) "Administrator" means the Administrator of the Environmental Protection Agency.

...) "Ambient air" means that portion ...he atmosphere, external to buildings, ...which the general public has access.

...) "Reference method" means a ...hod of sampling and analyzing for ...air pollutant, as described in an ap...dix to this part.

...g) "Equivalent method" means any ...hod of sampling and analyzing for ...air pollutant which can be demon...ated to the Administrator's satisfac...n to have a *consistent relationship* to ...reference method.

...102 Scope.

...a) National primary and secondary ...bient air quality standards under sec...n 109 of the Act are set forth in this ...t.

...b) National primary ambient air ...ality standards define levels of air ...ality which the Administrator judges ...necessary, with an adequate margin ...safety, to protect the public health. ...tional secondary ambient air quality ...ndards define levels of air quality ...ich the Administrator judges neces...y to protect the public welfare from ...y known or anticipated adverse effects ...a pollutant. Such standards are sub...t to revision, and additional primary ...d secondary standards may be promul...ted as the Administrator deems neces...y to protect the public health and ...lfare.

(c) The promulgation of national ...imary and secondary ambient air qual...y standards shall not be considered in ...y manner to allow significant deterior...ion of existing air quality in any por...on of any State.

(d) The proposal, promulgation, or revision of national primary and secondary ambient air quality standards shall not prohibit any State from establishing ambient air quality standards for that State or any portion thereof which are more stringent than the national standards.

§ 410.3 Reference conditions.

All measurements of air quality are corrected to a reference temperature of 25° C. and to a reference pressure of 760 millimeters of mercury (1,013.2 millibars).

§ 410.4 National primary ambient air quality standards for sulfur oxides (sulfur dioxide).

The national primary ambient air quality standards for sulfur oxides, measured as sulfur dioxide by the reference method described in Appendix A to this part, or by an equivalent method, are:

(a) 80 micrograms per cubic meter (0.03 p.p.m.)—annual arithmetic mean.

(b) 365 micrograms per cubic meter (0.14 p.p.m.)—Maximum 24-hour concentration not to be exceeded more than once per year.

§ 410.5 National secondary ambient air quality standards for sulfur oxides (sulfur dioxide).

The national secondary ambient air quality standards for sulfur oxides, measured as sulfur dioxide by the reference method described in Appendix A to this part, or by an equivalent method, are:

(a) 60 micrograms per cubic meter (0.02 p.p.m.)—annual arithmetic mean.

(b) 260 micrograms per cubic meter (0.1 p.p.m.)—maximum 24-hour concentration not to be exceeded more than once per year, as a guide to be used in assessing implementation plans to achieve the annual standard.

(c) 1,300 micrograms per cuibc meter (0.5 p.p.m.)—maximum 3-hour concentration not to be exceeded more than once per year.

§ 410.6 National primary ambient air quality standards for particulate matter.

The national primary ambient air quality standards for particulate matter, measured by the reference method described in Appendix B to this part, or by an equivalent method, are:

(a) 75 micrograms per cubic meter—annual geometric mean.

(b) 260 micrograms per cubic meter—maximum 24-hour concentration not to be exceeded more than once per year.

§ 410.7 National secondary ambient air quality standards for particulate matter.

The national secondary ambient air quality standards for particulate matter, measured by the reference method described in Appendix B to this part, or by an equivalent method, are:

(a) 60 micrograms per cubic meter—annual geometric mean, as a guide to be used in assessing implementation plans to achieve the 24-hour standard.

(b) 150 micrograms per cubic meter—maximum 24-hour concentration not to be exceeded more than once per year.

§ 410.8 National primary and secondary ambient air quality standards for carbon monoxide.

The national primary and secondary ambient air quality standards for carbon monoxide, measured by the reference method described in Appendix C to this part, or by an equivalent method, are:

(a) 10 milligrams per cubic meter (9 p.p.m.)—maximum 8-hour concentration not to be exceeded more than once per year.

(b) 40 milligrams per cubic meter (35 p.p.m.)—maximum 1-hour concentration not to be exceeded more than once per year.

§ 410.9 National primary and secondary ambient air quality standards for photochemical oxidants.

The national primary and secondary ambient air quality standard for photochemical oxidants, measured and corrected for interferences due to nitrogen oxides and sulfur dioxide by the reference method described in Appendix D to this part, or by an equivalent method, is: 160 micrograms per cubic meter (0.08 p.p.m.)—maximum 1-hour concentration not to be exceeded more than once per year.

§ 410.10 National primary and secondary ambient air quality standard for hydrocarbons.

The hydrocarbons standard is for use as a guide in devising implementation plans to achieve oxidant standards.

The national primary and secondary ambient air quality standard for hydrocarbons, measured and corrected for methane by the reference method described in Appendix E to this part, or by an equivalent method, is: 160 micrograms per cubic meter (0.24 p.p.m.)—maximum 3-hour concentration (6 to 9 a.m.) not to be exceeded more than once per year.

§ 410.11 National primary and secondary ambient air quality standard for nitrogen dioxide.

The national primary and secondary ambient air quality standard for nitrogen dioxide, measured by the reference method described in Appendix F to this part, or by an equivalent method, is: 100 micrograms per cubic meter (0.05 p.p.m.)—annual arithmetic mean.

APPENDIX A—REFERENCE METHOD FOR THE DETERMINATION OF SULFUR DIOXIDE IN THE ATMOSPHERE (PARAROSANILINE METHOD)

1. *Principle and Applicability.* 1.1 Sulfur dioxide is absorbed from air in a solution of potassium tetrachloromercurate (TCM). A dichlorosulfitomercurate complex, which resists oxidation by the oxygen in the air, is formed (*1*, 2). Once formed, this complex is stable to strong oxidants (e.g., ozone, oxides of nitrogen). The complex is reacted with pararosaniline and formaldehyde to form intensely colored pararosaniline methyl sulfonic acid (3). The absorbance of the solution is measured spectrophotometrically.

1.2 The method is applicable to the measurement of sulfur dioxide in ambient air using sampling periods up to 24 hours.

New Mexico Environmental Improvement Board
P.E.R.A. Building
P. O. Box 2348
anta Fe, New Mexico 87501

RECEIVED
JUN 23 1975
U. S. Geological Survey
Carlsbad, N.M.

April 19, 1974

AIR QUALITY CONTROL REGULATION

Section Number 201 of the Ambient Air Quality Standards and Air Quality Control Regulations adopted by the New Mexico Health and Social Services Board on January 23, 1970, amended on June 26, 1971, and amended on June 16, 1973, is adopted to read:

"201. Ambient Air Quality Standards

A. The maximum allowable concentrations of total suspended particulate in the ambient air are as follows:

	Maximum Concentration
1. 24-hour average	150 µg/m^3
2. 7-day average	110 µg/m^3
3. 30-day average	90 µg/m^3
4. annual geometric mean	60 µg/m^3

B. When one or more of the following elements are present in the total suspended particulate, the maximum allowable concentrations of the elements involved, based on a thirty-day average, are as follows:

	Maximum Concentration
1. beryllium	0.01 µg/m^3
2. asbestos	0.01 µg/m^3
3. heavy metals (total combined)	10 µg/m^3

C. The maximum allowable concentrations of the following air contaminants in the ambient air are as follows:

	Maximum Concentration
1. sulfur dioxide	

(a) 24-hour average 0.10 ppm

(b) annual arithmetic average 0.02

2. hydrogen sulfide

(a) for the state, except the Pecos-Permian Basin Intrastate Air Quality Control Region (1-hour average)

0.003 ppm

(b) for the Pecos-Permian Basin Intrastate Air Quality Control Region (1/2-hour average)

0.100 ppm

(c) after January 1, 1976, for within corporate limits of municipalities within the Pecos-Permian Basin Intrastate Air Quality Control Region (1/2-hour average)

0.030 ppm

(d) after January 1, 1978, for within five miles of the corporate limits of municipalities having a population of greater than twenty thousand and within the Pecos-Permian Basin Intrastate Air Quality Control Region (1/2-hour average)

0.030 ppm

3. total reduced sulfur

(a) for the state, except the Pecos-Permian Basin Intrastate Air Quality Control Region including hydrogen sulfide (1-hour average)

0.003 ppm

(b) for the Pecos-Permian Basin Intrastate Air Quality Control Region, except for hydrogen sulfide (1/2-hour average)

0.010 ppm

(c) after January 1, 1976, for within corporate limits of municipalities within the Pecos-Permian Basin Intrastate Air Quality Control Region, except for hydrogen sulfide (1/2-hour average)

0.003 ppm

(d) after January 1, 1978, for within five miles of the corporate limits of municipalities having a population of greater than twenty thousand and within the Pecos-Permian Basin Intrastate Air Quality Control Region, except for hydrogen sulfide (1/2-hour average)

0.003 ppm

		Maximum Concentration
4.	carbon monoxide	
	(a) 8-hour average	8.7 ppm
	(b) 1-hour average	13.1 ppm
5.	nitrogen dioxide	
	(a) 24-hour average	0.10 ppm
	(b) annual arithmetic average	0.05 ppm
6.	photochemical oxidants (1-hour average)	0.06 ppm
7.	non-methane hydrocarbons (3-hour average)	0.19 ppm

D. On an annual average, the soiling index shall not exceed 0.4 cohs/1000 linear feet of air."

Adopted: 4-19-74

Filed: 5-3-74

Effective: 6-2-74

AIR QUALITY DATA REPORT
****

AGENCY STATE AGENCY   STATE NEW MEXICO   CITY PAGUATE -8D SITE 003 YEAR 1975

POLLUTANT TOTAL SUSPENDED PART.   UNITS U GM/M3 (25DEG)   DATA FORMAT XXX.X

MONTH
*****

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	N	MEAN
01			41.5										1	41.5
02													0	
03		41.4											1	41.4
04								28.0					1	28.0
05		37.0				34.7							2	35.9
06													0	
07			68.9										1	68.9
08													0	
09									11.3				1	11.3
10								48.6					1	48.6
11		31.6				36.2	11.0						3	26.3
12				21.9									1	21.9
13	58.2												1	58.2
14													0	
15									28.3				1	28.3
16								19.5					1	19.5
17		21.5	150.8			43.4	30.3						4	61.5
18	35.5												1	35.5
19			74.8										1	74.8
20													0	
21								23.2	30.3				2	26.8
22													0	
23		54.0											1	54.0
24	33.0												1	33.0
25			60.7	55.6									2	58.2
26													0	
27									57.4				1	57.4
28													0	
29													0	
30													0	
31			43.5										1	43.5
N	3	5	6	2		3	2	4	4				29	
MN	42.2	37.1	73.4	38.8		38.1	20.7	29.8	31.8				29	42.5
MX	58.2	54.0	150.8	55.6		43.4	30.3	48.6	57.4				29	150.8

Annual Geometric Mean 36.8

APPENDIX VII

Hydrologist's Memorandum Report

United States Department of the Interior
GEOLOGICAL SURVEY
P.O. BOX 1716
CARLSBAD, NEW MEXICO 88220

IN REPLY
REFER TO:

March 19, 1976

Memorandum

To: District Chief, WRD, USGS,
Albuquerque, New Mexico

From: Area Mining Supervisor, SRMA, USGS,
Carlsbad, New Mexico

Subject: The Anaconda Company's Proposed Mining and Reclamation Plan for the P-15 and P-17 Mines on Laguna Tribal Lease No. 4

Please review the enclosed copy of the above plan (one volume with map pocket) and return with your report.

Dale C. Jones

Dale C. Jones
Mining Engineer
for Area Mining Supervisor

DCJ:nb

Enclosure:

OPTIONAL FORM NO. 10
MAY 1962 EDITION
GSA FPMR (41 CFR) 101-11.6

UNITED STATES GOVERNMENT

Memorandum

TO : Area Mining Supervisor, SRMA, USGS, Carlsbad, NM DATE: March 26, 1976

FROM : District Chief, WRD, USGS, Albuquerque, NM

SUBJECT: Review of the Anaconda Company's proposed mining and reclamation plan for the P-15 and P-17 mines on Laguna Tribal lease No. 4

I have reviewed the above mining plan and agree that the stated impacts of these two underground mines on water resources will be relatively minor for the reasons stated. In other parts of New Mexico where mine dewatering is a problem, the mines are several hundred feet below the water table. In this area mining will be done at or just below the water table, so yields from the relatively impermeable material will be low and drawdown will be small.

Although the discharges will probably be low, the 1.28 and 1.29 acre settling ponds for mine water may be too small. In this area annual evaporation is probably 6 feet or less from ponds, implying that, on the average, evaporation will consume about 5 gallons per minute from each of the two ponds. Perhaps provision should be made in the plan for discharges exceeding 5 gallons per minute. The ponds must have sufficient volume to contain winter discharges when evaporation rates are lower than 5 gallons per minute. Also, the ponds should be designed to minimize leakage, which could cause contamination of ground water in the area.

Forest P. Lyford

F. P. Lyford
Hydrologist

For: W. E. Hale
District Chief

RECEIVED
MAR 29 1976
U. S. Geological Survey
Carlsbad, N. M.

United States Department of the Interior
GEOLOGICAL SURVEY
P.O. BOX 1716
CARLSBAD, NEW MEXICO 88220

IN REPLY
REFER TO:

May 21, 1976

Memorandum

To: District Chief, WRD, USGS, Albuquerque, New Mexico

From: Area Mining Supervisor, SRMA, USGS, Carlsbad, New Mexico

Subject: The Anaconda Company's Proposed Mining and Reclamation Plan for the P-15 and P-17 Uranium Mines on Laguna Tribal Lease No. 4

Enclosed are copies of the subject plan, the company's addendums to the plan, and your original memorandum report on the plan dated March 26, 1976.

Please review the enclosed material to see if the addendums to the plan necessitate revision or addition to your original report. Please return the plan and addendums to this office.

Dale C. Jones

Dale C. Jones
Mining Engineer
for Area Mining Supervisor

DCJ:cj

Enclosures

OPTIONAL FORM NO. 10
MAY 1962 EDITION
GSA FPMR (41 CFR) 101-11.6

UNITED STATES GOVERNMENT

Memorandum

TO : Area Mining Supervisor, SRMH, USGS, Carlsbad, NM

DATE: May 26, 1976

FROM : District Chief, WRD, USGS, Albuquerque, NM

SUBJECT: Addendums to the Anaconda Company's Proposed Mining and Reclamation Plan for the P-15 and P-17 Uranium Mines.

I have reviewed the addendums to Anaconda Company's Proposed Mining and Reclamation Plan and have only a couple of comments. First, the pumping rate at 183 gpm from the P-10 mine reported in the letter dated April 14, 1976, does not agree with the pumping rate reported in the letter dated April 21, 1976, which averaged about 30 gpm as calculated from the total water pumped. Second, reference was made to our water resources study on the Pueblo of Laguna. We have water quality data in the form of miscellaneous chemical analyses and specific conductance measurements for both Paguate Reservoir and the other, which is called New Laguna Reservoir. This can probably be supplied upon written consent from the Laguna Governor. Both reservoirs are nonfunctioning because of sediment filling.

Enclosed is the mining plan with addendums.

Forest P. Lyford

F. P. Lyford
Hydrologist

For: W. E. Hale
District Chief

Encl.

RECEIVED

MAY 27 1976

U. S. Geological Survey
Carlsbad, N.M.

OPTIONAL FORM NO. 10
MAY 1962 EDITION
GSA FPMR (41 CFR) 101-11.6

UNITED STATES GOVERNMENT

Memorandum

TO : Area Mining Supervisor, Conservation Division DATE: Aug. 25, 1977

William E. Hale

FROM : District Chief, Water Resources Division

SUBJECT: Modification of The Anaconda Company's Mining and Reclamation Plan for the P-15 and P-17 Mines (Underground-Uranium), Pueblo of Laguna Uranium Mining Lease No. 4, Valencia County, New Mexico

We have reviewed the modification to the subject mining plan and found no reason to modify the comments included in memorandum reports dated March 26 and May 26, 1976.

Thank you for the opportunity to review this plan.

United States Department of the Interior

GEOLOGICAL SURVEY
Conservation Division
P. O. Box 26124
Albuquerque, New Mexico 87125

August 17, 1977

Memorandum

To: District Chief, Water Resources Division

From: Area Mining Supervisor

Subject: Modifications of The Anaconda Company's Mining and Reclamation Plan for the P-15 and P-17 Mines (Underground-Uranium), Pueblo of Laguna Uranium Mining Lease No. 4, Valencia County, New Mexico

Enclosed are copies of the subject modifications, the original mining plan with addendums, and your previous memorandum reports regarding the plan dated March 26 and May 26, 1976.

Please review the enclosed material to see if the modifications of the plan necessitate revision of or addition to your reports. Please return all of the enclosed material.

DALE C. JONES
Mining Engineer
For Area Mining Supervisor

Enclosures

RECEIVED
USGS WRD
AUG 17 1977
ALBUQ., N. MEX.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

CONFIDENTIAL

APPENDIX VIII

Water Quality Data

Table 1

Analytical Data for Surface Water Sampling (EPA, 1975, p. 33)

Station Description	Number of Samples	Gross Alpha (pCi/l)			Radium-226 (pCi/l)			Uranium (mg/l)			Selenium (mg/l)			Vanadium (mg/l)		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
Rio Paguate at Paguate	1	-	-	2.8	-	-	0.11	-	-	<0.02	-	-	<0.01	-	-	0.6
Rio Moquino upstream of Jackpile Mine	1	-	-	11.2	-	-	0.17	-	-	<0.02	-	-	<0.01	-	-	1.8
Rio Paguate at Jackpile Ford	1	-	-	270	-	-	4.8	-	-	1.2	-	-	<0.05	-	-	0.5
Rio Paguate at Paguate Reservoir Discharge	1	-	-	230	-	-	1.94	-	-	1.1	-	-	<0.01	-	-	0.6
Rio San Jose at Interstate Bridge	1	-	-	38	-	-	0.37	-	-	0.10	-	-	<0.01	-	-	0.3

ALKALINITY

Alkalinity in drinking water should be sufficient to enable floc formation during coagulation, but not so high as to cause physiological distress in humans. A chemically balanced water, neither corrosive nor encrusting, should be maintained. Alkalinity should not be less than 30 mg/l nor more than 500 mg/l (3).

ARSENIC

The use of inorganic arsenic in insecticides necessitates the need for a limit on the concentration of arsenic in drinking water supplies. A considerable proportion is retained by the body at low intake levels (2). The United States Public Health Service Drinking Water Standards of 1962 set concentration limit not to exeed 0.01 mg/l.

BARIUM

Barium is considered a general muscle stimulant, especially the heart muscle (2). The fatal dose for man is 550-600 mg. Concentrations of barium have been set by the United States Public Health Service Drinking Water Standards of 1962 at 1.0 mg/l because of the toxic effect on the heart, blood vessels, and nerves.

BICARBONATE

Bicarbonate is a universal constituent of natural waters. Bicarbonate has not been considered as a health hazard. However, some reports indicate that concentrations in excess of 700 mg/l may be harmful to some persons. Bicarbonate is an essential constituent in water as it provides a buffering capacity to the water.

BORON

The ingestion of large amounts of boron can affect the central nervous system and protracted ingestion may result in a clinical syndrome known as borism. Boron is an essential element to plant growth, but is toxic to many plants at levels as low as 1 mg/l. The United States Public Health Service has established a limit of 1 mg/l which provides a good factor of safety physiologically and also considers the domestic use of water for home gardening (3).

CADMIUM

Cadmium is believed to be a nonessential, nonbeneficial element biologically. Cadmium also has a high toxic potential. Minute amounts are known to interfere with metabolism and cause arterial changes in man. Because of this, the United States Public Health Service Drinking Water Standards of 1962 set the allowable concentration of cadmium at 0.01 mg/l.

CALCIUM

Calcium salts and calcium ions are among the most commonly encountered substances in water. They may result from leaching of soil and other natural sources, or they may be contained in sewage and many types of industrial waste. The United States Public Health Service Drinking Water Standards do not carry any limit for calcium. The World Health Organization International Standards of 1958 indicates 75 mg/l is a permissible lim and 200 mg/l is an excessive limit in drinking water.

CARBONATE

Carbonate is directly related to bicarbonate and th concentration of each varies with the pH. The Unite States Public Health Service Drinking Water Standards o 1962 place no restrictions on carbonates in natur waters, nor in chemically treated waters, as was done i the 1946 standards. Concentration in excess of 350 m of carbonate should not be allowed in drinking wat because it may be harmful to some people.

CHLORIDE

Chlorides in drinking water are generally not harmful t human beings until high concentrations are reache although chlorides may be harmful to some peop suffering from diseases of the heart or kidney Restrictions on chloride concentrations are general based on palatability requirements rather than health. concentration exceeding 250 mg/l is not recommende

CHROMIUM

The relationship or effect of chromium on the hum body is not known. Chromium is not known to be common element of food sources. That which may b found usually arises from cooking in stainless steel po The United States Public Health Service Drinking Wat Standards of 1946 set as the allowable concentration chromium at 0.05 mg/l based on the lowest amou analytically determinable at the time the standard w established.

COLOR AND ODOR

Color and odor requirements are easily attained properly designed and operated treatment plants. Wh the requirements are not met, it is an indication inadequate facilities or operation of the system. T United States Public Health Service Drinking Wat Standards set the limit of color at 15 units and odor at units. These values do not reflect the safety of the wat but rather the consumer acceptance.

CONDUCTANCE

Conductivity is the reciprocal of electrical resistance ohms of a column of solution one centimeter long wit cross section of one square centimeter at a specifi temperature. The greater the concentration of dissolv ionic constituents in water, the less its resistance current flow. Thus, conductivity serves as a measure the total dissolved solids in the water. S concentrations may rise to levels harmful to livi organisms because of the increase in osmotic pressu Conductance should be below 1,000 micromhos at 2 for good drinking water quality.

COPPER

Copper is an essential and beneficial element in hun metabolism. A deficiency in copper results in nutritional anemia in infants. The daily requirement for adults has been estimated at 2.0 mg. Higher concentrations of copper impart an undesirable taste to drinking water. Because of this, the United States Public Health Service Drinking Water Standards ~~raised~~ lowered the recommended level from ~~0.2~~ 3.0 mg/l in 1946 to ~~3.0~~ 1.0 mg/l in 1962.

CYANIDE

Cyanide standards are based on the toxicity for fish and not for man. Lethal toxic effects occur only when the detoxifying mechanism of the body (conversion to thiocyanate) is overburdened. The United States Public Health Service Drinking Water Standards set the recommended limit of 0.01 mg/l.

FLUORIDE

There are numerous articles describing the effect of fluoride-bearing water on the dental enamel of children. These papers indicate that water containing less than 0.9 to 1.0 mg/l of fluoride will seldom cause mottled teeth in children, and for adults concentrations less than 3 or 4 mg/l are not likely to cause endemic cumulative fluorosis and skeletal effects. There is evidence to support the contention that fluorides in excess of the threshold for mottling teeth, and up to 5 mg/l, produce no harmful effects other than mottling.

The United States Public Health Service Drinking Water Standards of 1962 set a limit on fluorides at twice the optimum level shown in the following table. Recommended levels are based on an average of maximum daily air temperatures in accordance with the following table. It is reasoned that children drink more water in warm climates; hence, fluoride content in the water should be lower to prevent excessive total fluoride consumption.

TABLE

ANNUAL AVERAGE OF MAXIMUM DAILY AIR TEMPERATURES °F			RECOMMENDED CONTROL LIMITS OF FLUORIDE AND mg/l		
			LOWER	OPTIMUM	UPPER
50.0	—	53.7	0.9	1.2	1.7
53.8	—	58.3	0.8	1.1	1.5
58.4	—	63.8	0.8	1.0	1.3
63.9	—	70.6	0.7	0.9	1.2
70.7	—	79.2	0.7	0.8	1.0
79.3	—	90.5	0.6	0.7	0.8

GROSS BETA, RADIUM 226, STRONTIUM

The United States Public Health Service Drinking Water Standards set a limit of 3 *uuc* per liter and 10 *uuc* per liter for radium 226 and strontium 90 respectively. The standards set as an upper limit of gross beta activity at 1,000 *uuc* per liter in the absence of strontium 90 and alpha emitters.

HARDNESS

Hardness over 100 mg/l as CaCo3 becomes increasingly inconvenient because it results in waste of soap and encrustation on utensils. The major detrimental effect of hardness is economic. For this reason the 1962 United States Public Health Service Drinking Water Standards have not set health-related limits on this parameter; but, softening is recommended for waters with a hardness above 250 mg/l.

IRON

The 1962 United States Public Health Service Drinking Water Standards set the recommended limit for iron at 0.3 mg/l for aesthetic reasons, such as staining of fixtures and clothing. This limit is not based upon physiological considerations, for iron in trace amounts is essential for nutrition. The daily nutritional requirement is 1 to 2 mg, and most diets contain 7 to 35 mg per day. Consequently, drinking water containing iron is unpalatable and unaesthestic concentrations constitute a nuisance but have little effect on the total daily intake.

LEAD

Lead is very toxic if taken into the body by either brief or prolonged exposure. Lead is a cumulative poison. Lead is absorbed from food, air, water, and tobacco smoke. The United States Public Health Service Drinking Water Standards set the limit at 0.05 mg/l.

MAGNESIUM

Magnesium is an essential mineral element for human beings. The daily requirement for human beings is about 0.7 grams. Magnesium is considered relatively non-toxic to man and not a public health hazard. Before toxic conditions are reached in water the taste becomes quite unpleasant. At high concentration magnesium salts have a laxative effect, although the human body can develop a tolerance over a period of time. The 1946 United States Public Health Service Drinking Water Standards recommended a limit of 125 mg/l, but there is no limit in the 1962 standards.

MANGANESE

The 1962 United States Public Health Service Drinking Water Standards set the recommended limit for manganese at 0.05 mg/l. This requirement is the result of aesthetic considerations rather than any physiologic considerations.

Manganese is undesirable in domestic water supplies because it causes unpleasant tastes and stains, and fosters growth of some micro-organisms in reservoirs, filters, and distribution systems.

MERCURY

Mercury is found in seawater at a level of 0.00003 mg/l. It is found in marine plants at approximately 0.03 mg/l. Severe neurological disorders have been reported as a result of eating fish and shellfish from contaminated waters. For phytoplankton, the minimum lethal concentration of mercury salts has been reported to range from 0.9 to 60 mg/l of mercury. The toxic effects of mercury salts are accentuated by the presence of trace amounts of copper (3). The Technical Review Committee Tentative Standards have prepared in their revision of the Public Health Service Drinking Water Standards a maximum allowable unit of 0.005 mg/l mercury (4).

MOLYBDENUM

Molybdenum presents a particularly unique problem in irrigation waters in that ground waters frequently carry levels of the element that give rise to plant concentration toxic to cattle. In nutrient solution and soil solution measurements, 0.01 mg/l molybdenum in solution will produce legumes containing in the order of 5 mg/kg molybdenum or more in the tissue. This level is commonly accepted as the upper limit for safe feeding to cattle and it has been proposed as the tolerance limit. An upper limit of 0.05 mg/l has been proposed when the irrigation water is added to acid soils with a large capacity to combine with the element. The reason for this action is to protect against the possibility of inducing molybdenum toxicity at a later date as a result of overliming in humid and subhumid areas (3). The State has recommended a maximum allowable concentration of 0.01 mg/l for drinking water.

NICKEL

Nickel pollution is caused by industrial smoke and other wastes. It is very toxic to most plants but less to animals. Long-term studies with oysters found that a level of 0.121 mg/l nickel caused considerable mortality. Nickel toxicities occur in nature in conjunction with high levels of chromium in soils developed from serpentine rock. Growth of flax is depressed by the presence of 0.5 mg/l nickel and this value has been suggested for tentative tolerance limit in irrigation waters. Examination of more sensitive crops may suggest a lower value (3). The State has recommended a maximum allowable concentration of 0.05 mg/l for drinking water.

NITRATE

Until 1962, the United States Public Health Service Drinking Water Standards did not have a requirement for nitrates. At that time, however, a recommended limit of 45 mg/l for nitrates was established. This limit was established because of the relationship between high nitrates in water and infant methemoglobimenia.

pH

The pH of a water system was singled out by the early investigators of coagulation as the most important variable to be considered. The United States Public Health Service Drinking Water Standards recommend as the optimum a pH range of 6.0 to 8.5. Failure to operate within this range will result in chemical wasting and will be reflected in the quality of the treated water.

PHOSPHATE

The limit for phosphorus concentrations in public wate supplies has been considered, but it has not bee established because of the complexity of the problem The purpose of such limit would be twofold: (a) t avoid problems associated with algae and other aquati plants and (b) to avoid coagulation problems du particularly to complex phosphates (3).

POTASSIUM

Potassium is one of the more common elements. It is a essential nutritional element. The 1962 United State Public Health Service Drinking Water Standards do no specify any limit for potassium. A dose of 1 to 2 gram of potassium is cathartic, and 1,000 to 2,000 mg/l i regarded as the extreme limit of potassium in drinkin water (1).

SELENIUM

Before 1962, the presence of selenium in water wa considered a matter of regional importance. It is nov recognized as being toxic to both man and animals. Th presence of selenium may cause an increase in denta caries in man and is a potential carcinogenic. In the 194 release of the United States Public Health Servic Drinking Water Standards the level of allowable seleniun was 0.05 mg/l. Due to the seriousness of the effects, ir 1962 the standards lowered the limit to 0.01 mg/l.

SILVER

Crystalline silver nitrate, $AgNO_3$, is sometimes used as a disinfectant in water supplies. Because of its skin and mucuous membrane discoloration along with pathological changes in the kidneys, liver, and spleen the United States Public Health Service Drinking Water Standards have set the limit for silver at 0.05 mg/l.

SODIUM

Sodium salts are extremely soluble and are found in most natural waters. Sodium is the cation of many salts used in industry, and, as such, one of the most common ions in process wastes. Sodium in drinking water may be harmful to persons suffering from cardiac, renal, and circulatory diseases. The 1962 United States Public Health Service Drinking Water Standards do not establish a recommended level. However, it has been reported that levels of 200 mg/l may be injurious to some people.

SULFATE

The 1962 United States Public Health Service Drinking Water Standards recommend that sulfates do not exceed 250 mg/l. This limit does not appear to be based on taste or physiological effects other than a laxative action toward new users. Public water supplies with sulfate contents above this limit are commonly and constantly used without adverse effects.

SURFACTANTS

The surfactant is a synthetic organic chemical having high residual affinity at one end of its molecule and low residual affinity at the other. Its vigorous surface activity justifies not only its name, but its use as a prinicple ingredient in modern household detergents. In the past, the principle surfactant used was alkyl benzene sulfonate (ABS); however, recently the linear alkyl benzene sulfonate (LAS) has replaced it on the market. The reason for this is that LAS is more readily degradable by biological action than is the old ABS. The 1962 United States Public Health Service Drinking Water Standards do not contain any limits for the LAS concentration; however, they do recommend a limit of 0.5 mg/l ABS inasmuch as higher concentrations may cause undesirable taste and foaming.

TOTAL RESIDUE

Total residue is a measure of the dissolved solids content in a water. Because the concentration of total dissolved solids has little physiological effect, the 1962 United States Public Health Service Drinking Water Standards have no specific requirements. It is desirable to keep the concentration of dissolved solid below 500 mg/l in municipal water supplies. However, numerous communities in the Southwest are presently using water supplies well in excess of this value, with no harmful effects.

TURBIDITY

The turbidity of water is attributable to suspended and collodial matter, the effect of which is to reduce clarity and light penetration. Turbidity is undesirable in waters used for laundry, ice-making, bottled beverages, brewing, and steam boilers. The 1962 United States Public Health Service Drinking Water Standards specify that turbidity should not exceed five units.

WATER TEMPERATURE

The temperature of surface water is variable with geographical location. Consequently, no fixed criteria are feasible. The United States Public Health Service Drinking Water Standards do not list any limits for temperature. However, any of the following conditions are considered to detract from raw water quality for public use (3):

1. Water temperature higher than 29.5°C;
2. More than 0.6°C hourly temperature variation over that caused by ambient conditions;
3. More than 2.8°C water temperature increase in excess of that caused by ambient temperature;
4. Any water temperature change which adversely affects the biota, taste, and odor, or the chemistry of the water;
5. Any water temperature variation or change which adversely affects water treatment plant operation;
6. Any water temperature change that decreases the acceptance of the water for cooling and drinking purposes.

ZINC

Zinc is an essential and beneficial element in human metabolism. Total zinc in the adult averages 2 g. Zinc deficiency in animals leads to growth retardation that is overcome by adequate dietery zinc. The activity of several body enzymes is dependent on zinc (2). Excessive zinc salts act as gastrointestinal irritants and the illness is very acute but transitory. Occurring with zinc as impurities are cadmium and lead. In view of this, the 1962 United States Public Health Service Drinking Water Standards have set the concentration limit as 5.0 mg/l in order to keep the concentrations of cadmium and lead below allowable levels.

BIBLIOGRAPHY

(1) McKee and Wolf, WATER QUALITY CRITERIA, State of California, Publication No. 3-A, 1963

(2) United States Public Health Service, PUBLIC HEALTH SERVICE DRINKING WATER STANDARDS, 1962

(3) Federal Water Pollution Control Administration, WATER QUALITY CRITERIA, 1968

(4) United States Environmental Protection Agency, MANUAL OF EVALUATING PUBLIC DRINKING WATER SUPPLIES, 1971

<u>Table 2</u>

Water Quality Data
(NMEIA, 1974, p. 215, 217)

	Seboyeta 1 Seboyeta Main Spring	Seboyeta 2 Auxiliary Spring Well # 2	Seboyetita (BIBO) 1 BIBO Well Well # 1	Moquino 1 Jackpile Shop Well	Moquino 2 Jackpile Well # 2
	259	259	260	256	256
Latitude	35-13-35	35-13-06	35-10-40	35-08-05	33-09-10
Longitude	107-24-00	107-23-40	107-23-41	107-19-10	107-21-65
Sodium	94.30	87.40	25.30	450.80	296.70
Potassium	1.56	1.95	7.02	2.73	1.17
Calcium	6.00	10.00	74.00	14.00	4.00
Magnesium	82.40	0.60	21.90	3.10	7.90
Iron-Total	<0.25	<0.25	0.00	<0.25	<0.25
Manganese	<0.05	<0.05	<0.05	<0.05	<0.05
Chloride	2.40	3.60	7.40	27.20	18.60
Fluoride	0.49	0.50	0.33	1.55	1.50
Nitrate	<0.10	<0.10	0.08	<0.10	<0.10
Bicarbonate	255.50	223.00	341.60	404.30	384.50
Carbonate	None	None	None	None	None
Sulfate	13.40	40.50	58.30	664.00	337.90
Phosphate	-	-	0.02	-	-
Total Hardness	18.50	27.50	285.00	47.50	42.50
Alkalinity	209.40	182.80	280.00	331.40	315.20
Total Dissolved Residue	315.00	280.00	403.00	142.00	915.00
Surfactants	<0.05	<0.05	<0.05	<0.05	<0.05
pH	8.01	7.82	7.80	8.13	8.18
Odor	Negative	Negative	Normal	Negative	Negative
Color	Negative	Negative	Clear	Negative	Negative
Turbidity	0.40	0.40	0.20	0.80	0.50
Conductance Micromhos/cm 25°C	349.00	423.00	617.00	2,029.00	1,299.00
Arsenic	<0.010	<0.010	<0.010	<0.010	<0.010
Barium	Negative	Negative	Negative	Negative	Negative
Boron	Negative	Negative	Negative	0.520	0.250
Cadmium	Negative	Negative	Negative	Negative	Negative
Chromium	Negative	Negative	Negative	Negative	Negative
Copper	Negative	Negative	0.025	Negative	0.025
Cyanide	-	-	-	-	-
Lead	Negative	Negative	Negative	Negative	Negative
Mercury	-	-	-	-	-
Molybdenum	-	-	-	-	-
Nickel	Negative	Negative	Negative		Negative
Silver	Negative	Negative	Negative	Negative	Negative
Selenium	Negative	0.014	0.018	Negative	Negative
Zinc	Negative	Negative	0.070	0.060	Negative
Radium 226	-	-	-	-	-
Strontium	-	-	-		-
Gross Beta	-	-	-	-	-

Figure 1

Ground Water Sampling Sites in the Jackpile-Paguate Area
(EPA, 1975, p.58)

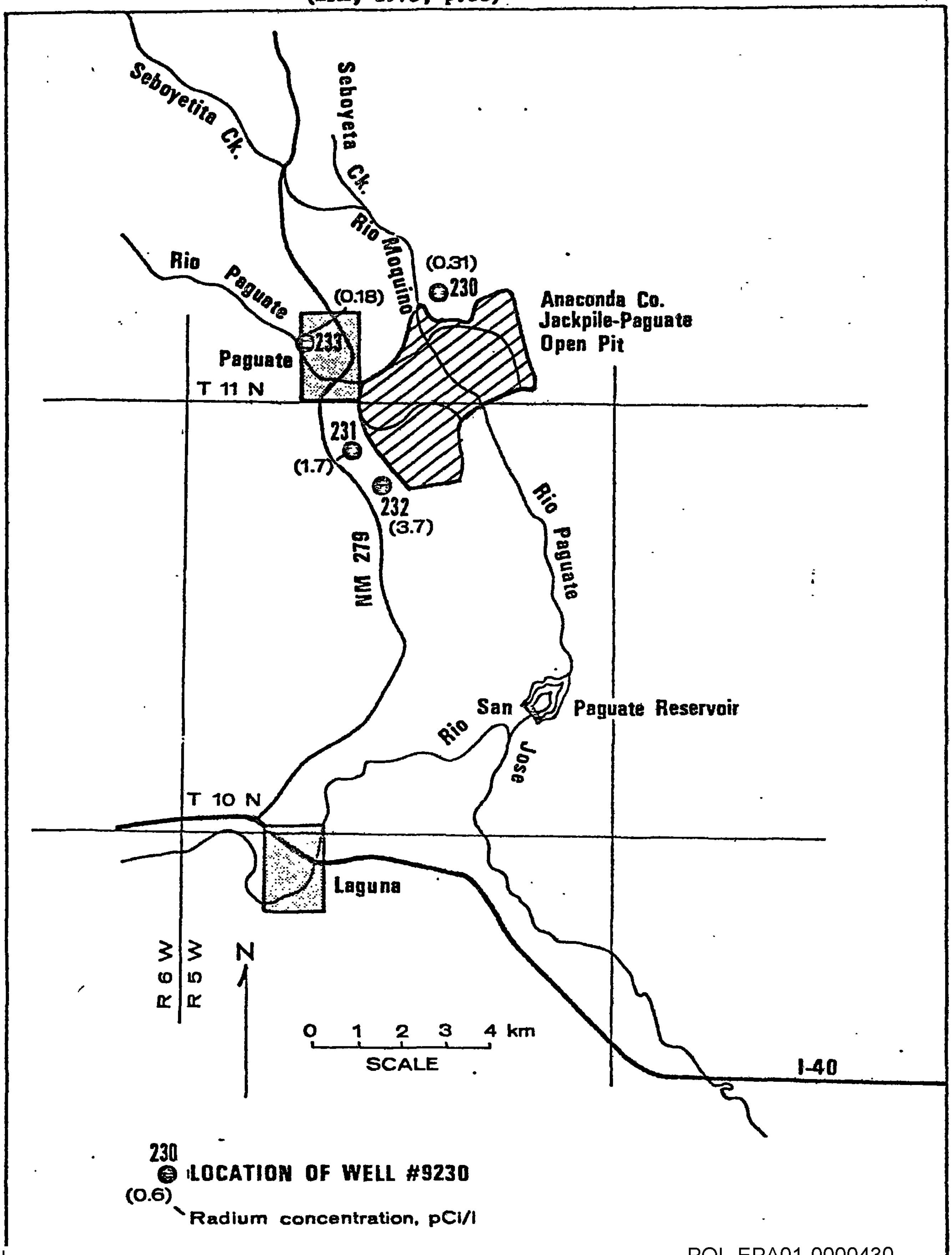


Table 3

Anaconda Water Analysis
(The Anaconda Company, 1976)

DESCRIPTION	Date	Cl ppm	SO_4 ppm	NO_3 ppm	Na ppm	Cond umhos	pH	U-Nat pCi/l	Ra-226 pCi/l	Th-230 pCi/l
Jackpile P-10 Well	2-5	24	539	2	470	1600	8.1	1.5	0.2	1.0
Jackpile New Shop Well	2-5	28	613	1	515	1500	8.1	1.4	1.0	1.5

APPENDIX IX

Archaeological Information

APPENDIX X

Bureau of Indian Affairs Comments

United States Department of the Interior

GEOLOGICAL SURVEY

P.O. BOX 1716

CARLSBAD, NEW MEXICO 88220

IN REPLY
REFER TO:

March 19, 1976

Memorandum

To: Superintendent, Southern Pueblos Agency, BIA, Albuquerque, New Mexico

From: Area Mining Supervisor, SRMA, USGS, Carlsbad, New Mexico

Subject: The Anaconda Company's Proposed Mining and Reclamation Plan for the P-15 and P-17 Mines on Laguna Tribal Lease No. 4

Enclosed are two copies of the plan (two volumes with map pocket) for your review. Please give us your recommendations, consistent with the requirements of the lease terms, for the protection of nonmineral resources and for the reclamation of the land surface affected by the plan.

Dale C. Jones

Dale C. Jones
Mining Engineer
for Area Mining Supervisor

DCJ:nb

Enclosure:

United States Department of the Interior
GEOLOGICAL SURVEY
P.O. BOX 1716
CARLSBAD, NEW MEXICO 88220

IN REPLY
REFER TO:

March 29, 1976

Memorandum

To: Superintendent, Southern Pueblos Agency, BIA, Albuquerque, New Mexico

From: Area Mining Supervisor, SRMA, USGS, Carlsbad, New Mexico

Subject: Addendum to The Anaconda Company's Proposed Mining and Reclamation Plan for the P-15 and P-17 Mines on Laguna Tribal Lease No. 4

Enclosed are two copies of the above addendum which are to be included with the plans submitted to your office with our memorandum of March 19, 1976. Any future addendums will be submitted to your office upon receipt.

Dale C. Jones
Dale C. Jones
Mining Engineer
for Area Mining Supervisor

DCJ:cj

Enclosures

United States Department of the Interior

GEOLOGICAL SURVEY

P.O. BOX 1716
CARLSBAD, NEW MEXICO 88220

IN REPLY
REFER TO:

May 21, 1976

Memorandum

To: Superintendent, Southern Pueblos Agency, BIA, Albuquerque, New Mexico

From: Area Mining Supervisor, SRMA, USGS, Carlsbad, New Mexico

Subject: The Anaconda Company's Proposed Mining and Reclamation Plan for the P-15 and P-17 Uranium Mines on Laguna Tribal Lease No. 4

Enclosed are two copies of the company's addendums to the subject plan which was submitted in duplicate to your office with our memorandum of March 19, 1976. These addendums should be included as parts of the plans.

Dale C. Jones
Mining Engineer
for Area Mining Supervisor

DCJ:cj

Enclosures

United States Department of the Interior

GEOLOGICAL SURVEY
Conservation Division
P. O. Box 26124
Albuquerque, New Mexico 87125

August 17, 1977

Memorandum

To: Superintendent, Southern Pueblos Agency, BIA

From: Area Mining Supervisor, SRMA

Subject: Modifications of the Mining and Reclamation Plan for the P-15 and P-17 Mines (Underground-Uranium), The Anaconda Company, Pueblo of Laguna Uranium Mining Lease No. 4

Enclosed are two copies of the subject modifications which should be made part of the original mining and reclamation plan that was submitted to your office March 19, 1976. The Environmental Analysis of the mining plan is being revised to include the modifications, and copies of the revisions will be forwarded to you as soon as possible.

DALE C. JONES
Mining Engineer
For Area Mining Supervisor

Enclosure

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

APPENDIX XI

Miscellaneous Information

Carlsbad

RECEIVED
JUL 22 1977
U. S. Geological Survey
Carlsbad, N.M.

Conservation Division
P. O. Box 26124
Albuquerque, New Mexico 87125

July 21, 1977

Memorandum

To: Files

From: Area Mining Supervisor

Subject: Inspection Jackpile—Paguate Mines, The Anaconda Company

On July 13, 1977, I examined the subject mines and attendant reclamation located on the Laguna Indian Reservation.

The inspection was requested by the Technical Committee of the Tribal Council.

The following people made the examination:

John Carrilo	– Technical Committee
Pete Maria	– Technical Committee
Bob Tsiosdia	– Technical Committee
Terry Farmer	– Tribal Lawyer
Bill Gray	– Anaconda Company

Anaconda started a program of grading and planting the tops of the large waste dumps in 1976. However, there are no plans to grade the sides of the waste dumps which are standing at the normal angle of repose. Some minor erosion is taking place on the sides of the dumps, but nothing serious at this time. Some planting will be tried on the sides at a later time.

The adit sites for the PW-2 and PW-3 mines located in the highwall were examined. Backfilling the North Paguate Pit has stopped pending approval of the mine plans and removal of the small amounts of ore involved.

The portal site of the slope which will develop the P15-P17 mine was examined.

All in all, it appears the members of the Technical Committee were satisfied with the reclamation work in progress. The necessity for approving the plans for the PW-2 and PW-3 mines in the near future was explained by the company representative. The small amount of ore involved must be removed to allow for the final backfilling of the pit and the grading of the highwall in the general area of the mine portals.

(ORIG. SGD.) A. F. CZARNOWSKY

A. F. CZARNOWSKY
Area Mining Supervisor

cc: Carlsbad

United States Department of the Interior

GEOLOGICAL SURVEY
P. O. Box 1716
Carlsbad, New Mexico 88220

July 13, 1977

Memorandum

To: Files, Mining Plan for P-15 and P-17 mines, The Anaconda Company, Pueblo of Laguna Uranium Mining Lease No. 4

From: Dale C. Jones, Mining Engineer, SRMA, USGS

Subject: Laguna Committee Meeting

The writer attended the subject meeting July 8, 1977, at the Pueblo of Laguna Council Room in Laguna, New Mexico. The Laguna Committee is responsible for reviewing mining and reclamation plans for proposed mining projects involving Pueblo of Laguna lands and does so in conjunction with the Southern Pueblos Agency of the BIA and the appropriate company representatives. The purpose of the subject meeting was to discuss the mining plan and environmental analysis (EA) for the P-15 and P-17 Mines, and attendees included the Laguna Committee, BIA Officials, representatives from the Anaconda Company and an attorney for the Pueblo of Laguna.

The P-15 and P-17 mining plan was submitted by the Anaconda Company March 18, 1976, and proposed the development of two small underground uranium mines through two separate vertical shafts. The proposed mine sites would have been located on Black Rim Mesa about 2 miles south of Paguate, New Mexico. The writer prepared an EA of the proposed mining plan, and copies of the EA have been reviewed by the committee. Subsequently, Anaconda has proposed changing the original mining plan to provide for developing both mines through a single adit, the portal of which would be located in North Oak Canyon.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

The first item of discussion was the possibility of processing the mining plan as originally submitted with subsequent processing of the single adit proposal as a supplement to the approved mining plan. The writer pointed out that the USGS did not consider the single adit as a significant modification of the mining plan, and that the single adit approach would cause less environmental damage than the two shafts originally proposed. However, the writer also indicated that revision of the EA to include the single adit modification would not take a considerable amount of time, and it was generally agreed that such a revision should be made prior to processing of the plan. This revision is pending a formal submittal of the proposed modification from Anaconda.

The remainder of the meeting was spent discussing each section of the EA. This discussion resulted in the comments and suggestions listed below.

1. The "Reclamation" section of the EA will be expanded to supply more detail, possibly including information from Anaconda's comprehensive mining and reclamation plan which covers all of the company's underground and open-pit mining operations near Paguate. A stipulation regarding future abandonment of the mine openings (adit portal and ventilation shafts) will be added to the "Recommendations" section of the EA.

2. A stipulation requiring the utilization of subsidence monitoring grid systems in areaswhere mining would approach State Highway 279 will be added to the "Recommendations" section.

3. It was generally agreed that the "Atmosphere" and "Hydrology" sections of the EA were adequate. The writer pointed out that it would be best to assess the impacts on air quality and water resources on a cumulative basis and that this would be done in the EA of the Comprehensive mining plan.

4. The proper archaeological clearances for the proposed mining project had not been obtained when the EA was completed. These clearances will be submitted with the adit modification and will be added to the EA.

5. A list of the fauna and flora that might possibly exist in the mining area will be included in the "Fauna and Flora" section or in the appendices.

6. The "Alternatives to the Proposed Action" section will be expanded to further discuss the merits and demerits of each mining method and the alternative of "no development".

7. The "Unavoidable Adverse Environmental Effects of the Proposed Action" section will be expanded to include a discussion of the extraction of a non-renewable resource.

8. The committee and the BIA officials pointed out that they want the preparer's determination regarding NEPA to remain in this EA and to be included in future EA's. According to current EA guidelines, the preparer does make such a determination.

Dale C. Jones
Dale C. Jones
Mining Engineer

DCJ:vmc

INSPECTION REPORT
April 15, 1977

Bluewater Mill
The Anaconda Company
Valencia County, New Mexico

U. S. Geological Survey
Conservation Division
Area Mining Supervisor
Southern Rocky Mountain Area
P. O. Box 1716
Carlsbad, New Mexico 88220

Dale C. Jones
Mining Engineer
May 24, 1977

The Anaconda Company's Bluewater Mill was inspected April 15, 1977, by the writer and Don Dixon, Superintendent of Mill Maintenance. The primary purpose of the tour was examination of the method used to sample the uranium ore for royalty determination purposes prior to processing.

The Bluewater Mill is located just east of Interstate Highway 40 about 8 miles northwest of Grants in Valencia County, New Mexico. The facility uses a hydrometallurgical process to extract uranium oxide (U_3O_8), commonly known as yellowcake, from the ore which is mined from the company's open-pit and underground workings on Pueblo of Laguna lands near Paguate about 50 miles to the east. The ore is transported from the mine to the mill in 100-ton, bottom-dump rail cars by the Atchinson Topeka and Santa Fe (ATSF) Railroad. Presently, the mill processes an average of about 2000 tons of ore per day (TPD), but on-going expansion and modification of the facility will increase its capacity to about 6000 TPD as well as allowing the processing of lower grade ore. The company currently has a considerable amount of its ore toll milled at Kerr-McGee Corporation's mill in Ambrosia Lake near Grants and at Sohio's mill which is about 5 miles north of the lessee's mining operations.

Upon arriving at the mill site, each railroad car is weighed on Fairbanks-Morse track scales at the ore trestle, and this weight is used for royalty determination purposes. The scales are checked every 3 months by the ATSF Scale Department who report the results to the New Mexico State Corporation Commission and to the Trans-Continental Freight Bureau, South Pacific Coast Territory, in San Francisco, California.

After being weighed, each railroad car is dumped into one of four bays under the ore trestle according to the grade of ore in the car as determined by the scanner at the mine railhead. The ore in each alley is thereby kept at an average grade of 0.255% + 0.02% U_3O_8, and this assures a uniform feed grade for the mill. The recipient alley and the car weight are recorded, and when the alley contains about eight carloads, it is known as a mill lot. Each lot is removed individually by a front-end loader and put into a Cedar-Rapids jaw crusher (25 x 40). From the jaw crusher, the ore is carried by conveyer belt to a sizing screen where oversized material is removed and recycled through a Cedar Rapids impact breaker (30 x 30). When properly sized, all of the ore is carried by conveyor belt to the sampling tower.

The sampling tower contains an automatic, continuous sampling system consisting of three automatic Geary-Jennings samplers, two Syntron vibrating feeders, one Tyler-Niagara vibrating screen, and two small Traylor gyratory crushers. The system is of AEC design.

The first sampler takes a 10% cut of the ore, about 200 pounds per ton, which is then fed via vibrating feeder into the second sampler which takes another 10% cut, or about 20 pounds per ton of ore. The second cut is then sized by the vibrating screen (oversized material is reduced by the gyratory crushers) and fed via vibrating feeder into the third, and final, sampler which takes another 10% cut, or about 1.5 pounds per ton of ore. All reject material from the sampling system is routed on to the five 500-ton fine ore bins and subsequently on into the milling circuit.

The final sample, approximately 1.5 pounds of ore, is assayed, and the uranium content thereby obtained is used for determing the royalty due. In the past, grab samples were taken from the railroad cars for moisture analysis, but this is now done in the sample tower. A sample of each ore lot is kept for an umpire assay in case the original assay result is disputed.

Although the milling circuit is physically quite complex, the hydrometallurgical process is actually very simple. The ore is leached with sulphuric acid which removes the uranium oxide and places it in solution. This solution is then mixed with resin beads which collect the U_3O_8 on their outer surfaces. The U_3O_8 is washed from the beads to form a pregnant solution from which the U_3O_8 is precipitated out. The precipitate, or yellowcake, is then dryed and packed into 500-pound, sealed metal drums for shipment to the respective buyers. Four yellowcake samples are taken from each drum-one for Anaconda, one for the buyer, and two umpire samples.

In the past, the Bluewater Mill also had a circuit which utilized carbonate leaching so that limestone uranium ore could be processed. This system was closed in 1975, and United Nuclear - Homestake Partners' mill between Ambrosia Lake and Grants is the only mill now capable of refining limestone ores. When the on-going expansion and modification are complete, the Bluewater Mill will utilize solvent extraction instead of the resin beads. This will not change the basic hydrometallurgical process but will increase the mill capacity and allow the processing of lower grade ore. Solvent extraction is used at Kerr-McGee Corporation's mill in Ambrosia Lake.

Dale C. Jones
Dale C. Jones
Mining Engineer

DCJ: vmc

Orig. to: Superintendent, Southern Pueblos Agency, BIA
cc: Governor, Pueblo of Laguna
Chief Branch of Mining Operations, USGS
Through: Conservation Manager, Central Region, USGS
Area Mining Supervisor, SRMA, USGS
✓Files

INSPECTION REPORT

Jackpile-Paguate Mining Operations
The Anaconda Company
Jackpile Mining Lease
and
Laguna Mining Lease No. 4
Laguna Indian Reservation
Valencia County, New Mexico

U. S. Geological Survey
Conservation Division
Area Mining Supervisor
Southern Rocky Mountain Area
P. O. Box 1716
Carlsbad, New Mexico 88220

Dale C. Jones
Mining Engineer
March 10, 1977

The Anaconda Company's Jackpile-Paguate uranium mining operations, both open-pit and underground, were examined February 15, 1977. The writer was accompanied on the inspection tours by Bill Clark of the USGS and Clifford Gibbs, John Nelson, and Greg Kasza of the company's underground operations section.

The mining operations are located within the Jackpile Mining Lease and Mining Lease No. 4 which were issued to The Anaconda Company by the Pueblo of Laguna May 7, 1952, and July 30, 1963, respectively. These leases occupy about 7,550 acres of the Laguna Indian Reservation, in Townships 10 and 11 North, Range 5 West, NMPM, near Paguate in Valencia County, New Mexico. The Pueblo of Laguna owns all of the surface and mineral rights involved and also administers the leases in conjunction with the BIA and the USGS.

The Jackpile-Paguate Pit is actually two adjacent open-pits, and the Paguate Pit is further designated the North and South Paguate Pits. The easternmost Jackpile Pit has produced uranium ore since discovery of the ore deposit in 1952 while the Paguate Pit has yielded ore since 1963. The North Paguate Pit has now been mined out, but the South Pit is still producing with new overburden stripping underway on its west end. Operations are conducted three shifts per day, 7 days per week resulting in the production of 4000+ tons per day (TPD), although this rate can vary significantly from day to day. In the Jackpile Pit, some overburden stripping is performed by Hamilton Construction, a private contractor, but Anaconda takes over the mining activities once the top of the ore bearing formation is encountered.

In the open-pits, the host rock for the uranium ore is the Jackpile Sandstone unit, a coarse grained arkosic sandstone which is the uppermost extent of the Brushy Basin Member of the Jurassic Morrison Formation. The Jackpile ranges from 50 to 200 feet in thickness in the mining areas and contains ore from 1 to 15 feet thick an an average depth of 135 feet. Generally, the ore in the Jackpile Pit is thicker and more uniform than that in the Paguate Pit. The grade of the ore ranges from about 0.02% to as much as 0.50% U_3O_8 in some areas.

Solid overburden is removed to the top of the Jackpile Sandstone by conventional drilling and blasting and subsequent loading into haulage trucks. Ingersoll-Rand, Chicago Pneumatic and Gardner-Denver rotary drill rigs bore 6 3/4-inch holes which are loaded primarily with ANFO (ammonium nitrate-fuel oil) for blasting. The number and pattern of the blast holes vary, depending on overburden characteristics, as does the addition of other blasting agents such as ANFO boosters and stick powder. Loading of the overburden is accomplished by such equipment as Caterpillar (Cat) D-9 bulldozers; Dart 600 (15-cubic yard capacity bucket) and Cat 992 (10-cubic yard capacity bucket) front-end loaders; and Euclid R-20 and R-50 (23- and 50-ton capacities respectively) haulage trucks. This type of procedure is also used to extract barren portions of the Jackpile Sandstone, and both overburden and Jackpile waste rock are transported to the mine waste dumps or used to backfill mined-out areas in the pits. The pit benches vary considerably in width and average about 35 feet in height.

Original exploration drilling for the open-pit ore was conducted on 50-foot centers. Once the stripping of overburden reaches the top of the Jackpile, the ore is further defined by development drilling on 25-foot centers. These 4 3/4-inch diameter development holes are drilled by truck-mounted, rotary drill rigs and are then probed at 2-foot intervals using an Eberline Geiger counter probe.

Once the development drilling has been completed, mining of the ore begins by ripping the bench surface with Cat D-9 bulldozers. The loosened muck is then probed to a depth of about 18 - 24 inches by a man using a "T" probe which counts gamma ray emissions for a set amount of time in counts per second (cps). Ore zones are determined by the probe readings and are marked accordingly on the surface with stakes and flags. Generally, the ore is removed first by D-9, Dart 600, Cat 992, and R-20 equipment although waste material sometimes must be removed first. This procedure is repeated as benching continued.

After the haulage trucks have been loaded with ore, they proceed directly to one of various scanners located in the pits. The scanner is a scintillation device that counts gamma ray emissions from the ore for 30 seconds, and the results are given to the scanner operator in cps. This cps reading is recorded and determines which stockpile the truck will proceed to.

Ore from both the open-pit and underground workings is stockpiled at various locations in the open-pits according to its mining area and grade. Open-pit and underground ore are stockpiled separately due to metallurgical characteristics, accounting purposes, and to avoid long haulage distances. According to Anaconda officials, there are several stockpiles that contain material with an average grade as low as 0.02-0.05% U_3O_8; and, due to the increased price of uranium, some waste dumps have been drilled to re-evaluate their ore content.

From the various stockpiles, a separate fleet of loading and haulage equipment transfers the ore to the Atchinson, Topeka and Santa Fe (ATSF) railhead which is located south of the Jackpile Pit. Here the ore is crushed prior to being loaded by conveyor belt into 100-ton railroad cars. The conveyor belt is equipped with a weightometer so that the cars can be loaded as close to 100 tons as possible because Anaconda must pay a penalty to ATSF if the cars contain more than this amount. The conveyor is also equipped with a scanner very similar to those in the pits so that the grade of the material loaded into the cars can be determined. Both the weight and grade of the ore loaded into each railroad car is recorded. Once loaded, the ore is then transported to the company's acid-leach mill in Bluewater about 8 miles west of Grants, New Mexico. Anaconda plans to expand the capacity of the mill from 2500 to 6000 tons per day as about 1000 tons per day of the open-pit ore is currently being toll milled on an irregular basis at Sohio's facility about 5 miles north of the Jackpile Pit. Modification of the mill would also allow the processing of lower grade ore according to company officials.

At the mill, the ore is sampled and assayed, and royalty payments are determined using the U_3O_8 assay. In the near future, the writer plans to tour the milling facility to examine these sampling and assaying procedures.

While touring the open-pit mining operations, the party also examined the area where the company's proposed PW2-PW3 Mine Project would be located. This project would be a scram type operation developed from an adit collared in the mined-out North Paguate Pit. The involved deposits contain an indicated 36,500 tons of ore with an average grade of about 0.27% U_3O_8 and are located on the fringes of more concentrated ore zones which were extracted using open-pit methods. It is not feasible to open-pit mine the PW2-PW3 deposits due to their close proximity to State Highway 279 and the village of Paguate. A mining and reclamation plan for the PW2-PW3 Mine Project was submitted January 5, 1977, and an environmental analysis of the plan is being prepared.

Also examined during the open-pit tour were the locations of the portals for the P-9-2, P-9-3 and P-11 Adit Mine Projects. These portals are located near the bottom of the small, mined-out P-9-1 open-pit which is situated on the southeast margin of the Paguate Pit. The P-9-2 Project was approved in 1974, and mining was halted in October or November of 1976 pending further exploration work. The P-9-3 and P-11 Projects were approved in 1975 as a supplement to the plan for the P-9-2 Project, but mining has been delayed pending further evaluation of the use of open-pit methods to extract this ore. Anaconda now plans to use underground methods for the P-9-2 and P-11 ore zones and is currently pumping water from the adits.

The company's operating underground mine is called the P-10 Mine, but it actually consists of two connected mining areas, the P-10 and P-7. The mine operates three 8-hour shifts per day, 5 days per week, and has a total of about 165 employees including staff and maintenance personnel. Current ore production is about 1000 tons per day. Due to its water content, most of this ore is being toll milled at Kerr-McGee Corporation's mill in Ambrosia Lake near Grants.

From the surface, access to both mining areas is provided by a declined shaft (about 12%) approximately 2000 feet in length. The decline (about 9 feet by 16 feet) is supported by steel sets with tight timber lagging and contains a 24-inch conveyor belt that carries ore and waste to the surface. At the bottom of the decline is a 300-tons per hour jaw crusher and the mine pump station and sump. About 120 to 130 gallons per minute of water are pumped from the mine for about 7 hours per shift.

In the P-10 mining area, the ore zones range from about 200 to 400 feet in depth, and ore extraction is accomplished using a modified room-and-pillar method with sublevel track haulage. Conventional equipment such as jackleg drills and triple-drum slushers is utilized; and stulls, timber and/or steel sets, and rock bolts with wire mesh and/or landing mats are used for ground support. Access from the haulage level to the ore zones is provided by various man- and serviceways which are strategically located throughout the mine area. Ore development drifts are driven on 45-foot centers leaving pillars that measure approximately 43 feet square.

Pillar removal results in an extraction rate of about 90%, and in some areas about 95%. The ore is transferred from the stopes to the haulage level through various ore passes that are also strategically located throughout the mine area. Some of these ore passes have been driven by conventional methods, but the majority of them are drilled by a Caldwell Raise Bore in which case they are bored with 52-inch diameters and then cased to 48-inch diameters. From the ore passes, the ore is loaded into side-dump railroad cars (car factor of 3.7 tons) which are pulled by 8-ton diesel engines to a dump station that feeds the crusher at the bottom of the decline.

The P-7 area is about 1000 feet northwest of the P-10 area, and the ore zones range from about 170 to 450 feet in depth. The mining method used here is the same as in the P-10 area except that LHD (load-haul-dump) equipment is being used to move the ore to the ore passes. Access to the stopes for the LHD's is provided by a ramp driven on a 20 to 25% slope between the ore and haulage levels. Presently, only development work is being performed in the P-7 area, and the entire area will be totally developed before pillar extraction beings. The development drifts are driven on 50-foot centers resulting in pillars about 47 feet square, and ground support consists primarily of timber and/or steel sets and rock bolts and landing mats. Wire mesh is not used in the stope areas to avoid entanglement with the buckets of the LHD's. Ore from the P-7 area is transported to the crusher dump by the same type of haulage equipment that is used in the P-10 area.

Once crushed, the ore and waste material from the P-7 and P-10 mining areas is carried separately up the decline to the surface by the 24-inch conveyor belt. On the surface, it is loaded into trucks and transported to the appropriate stockpile, dump or backfill area in the open-pits as previously discussed.

Ventilation of the P-10 and P-7 workings is accomplished by downcasting fresh air and exhausting contaminated air through various boreholes. These boreholes are drilled from the surface with 48-inch diameters, cased with steel tubing to 42-inch diameters, and equipped with electrically driven 60- to 100-horsepower axial-flow fans. Currently, about 250,000 cubic feet of air per minute are being used for ventilation.

Water from the P-7 and P-10 workings is collected in the sump at the bottom of the decline from where it is pumped to the surface. On the surface, this water is piped to a mined-out area of the Paguate Pit where it is impounded with water from the other open-pit and underground workings. The water is periodically withdrawn from this impoundment and applied to the various haulage and access roads for dust suppression.

Throughout the inspection tour of the open-pit and underground operations, no violations of lease terms were observed.

Dale C. Jones
Mining Engineer

DCJ:cj

Original to: Superintendent, BIA, Southern Pueblos Agency
cc: Governor, Pueblo of Laguna
Chief, Branch of Mining Operations
Through Regional Conservation Manager
Area Mining Supervisor, SRMA
Files

INSPECTION REPORT

The Anaconda Company
Laguna Tribal Lease
Laguna #4
Valencia County, New Mexico

U. S. Geological Survey
Conservation Division
P. O. Box 1716
Carlsbad, New Mexico 88220

Prepared By
Gregory Alan Edwards
Mining Engineer
August 9, 1976

The Anaconda Company's lease property was visited on July 16, 1976, by Dave Stewart, Alan Edwards and Paul Vogel of this office. The purpose of the visit was to discuss the proposed P-15 and P-17 mines and also to inspect the underground P-10 mine.

The underground mine tour was conducted by Mr. Milt Head, the P-10 mine foreman. Inspected during the tour were the primary crusher, the machine shop, the sublevel haulage drifts and several of the working faces.

Mr. Head also explained how Anaconda delineates the ore bodies to insure maximum ore recovery. The location and estimated boundaries of the ore bodies are first delineated by surface drilling. During mine development, exploration fans are drilled upright from the sub-level haulage drift at fifty foot spacings to further delineate the ore bodies prior to commencement of mining activities (see Section A-A and Section B-B, enclosed).

During the mine level development, further exploration is conducted. A ten foot hole is drilled vertically from every drift after each round of blasting. In addition to this, a fan of exploration holes is drilled outward from each heading when the ore body boundary is reached (see Point E, Figure 1, enclosed). This would insure that no pockets of additional ore lie outside and adjacent to the boundary.

Gregory Alan Edwards

Gregory Alan Edwards

Orig. to: Chief, Conservation Division
cc: Area Office, BIA, Albuquerque, New Mexico
cc: Files

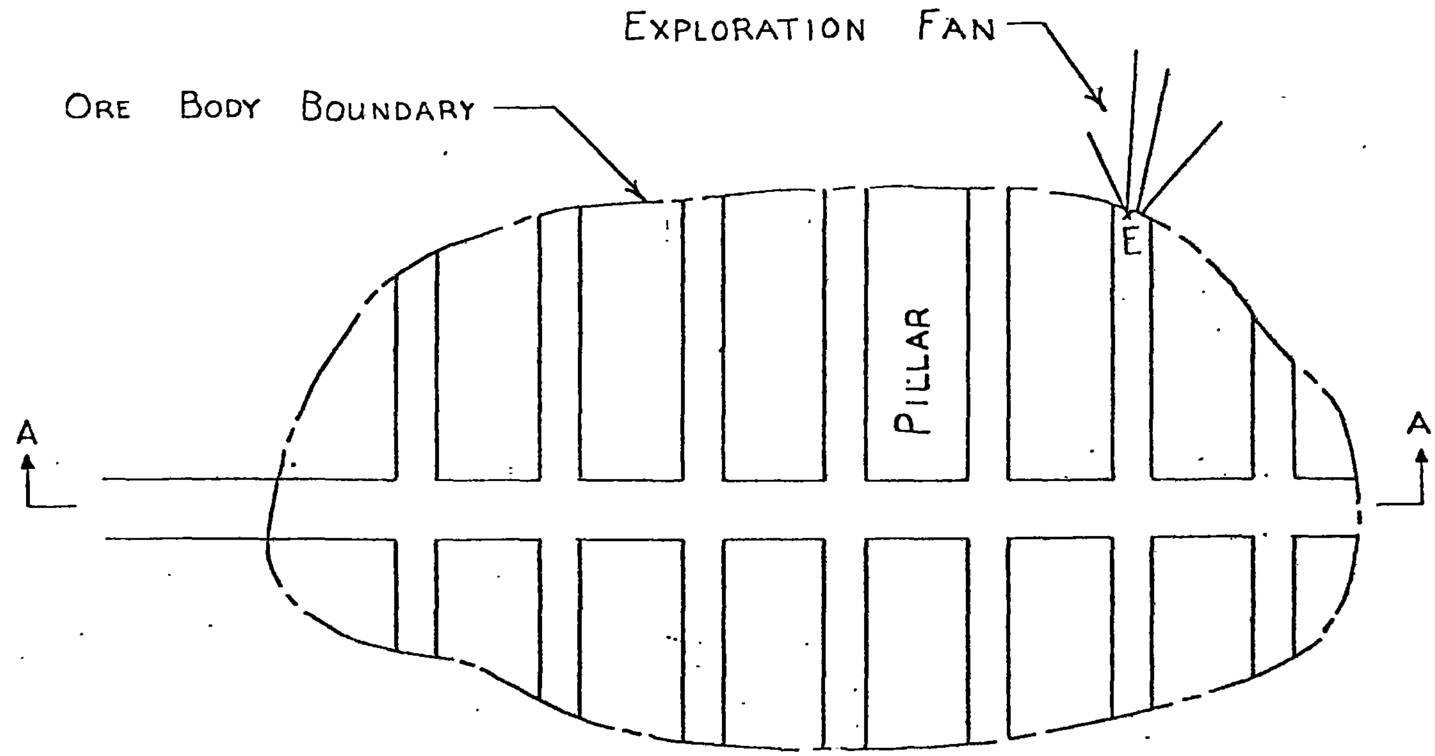
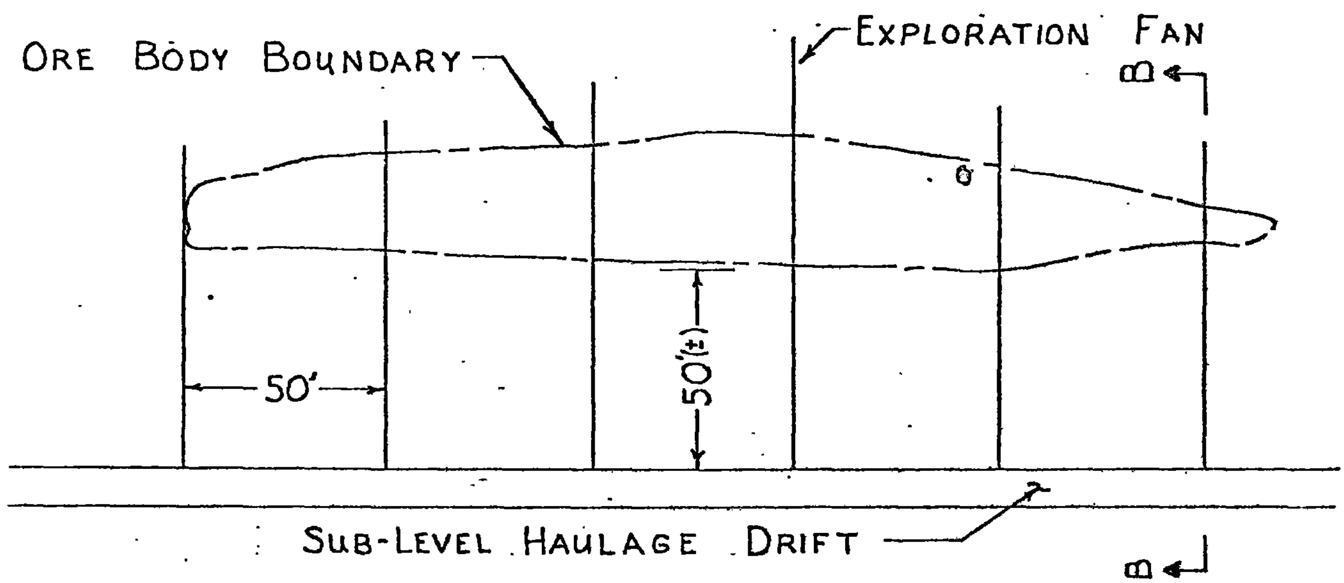
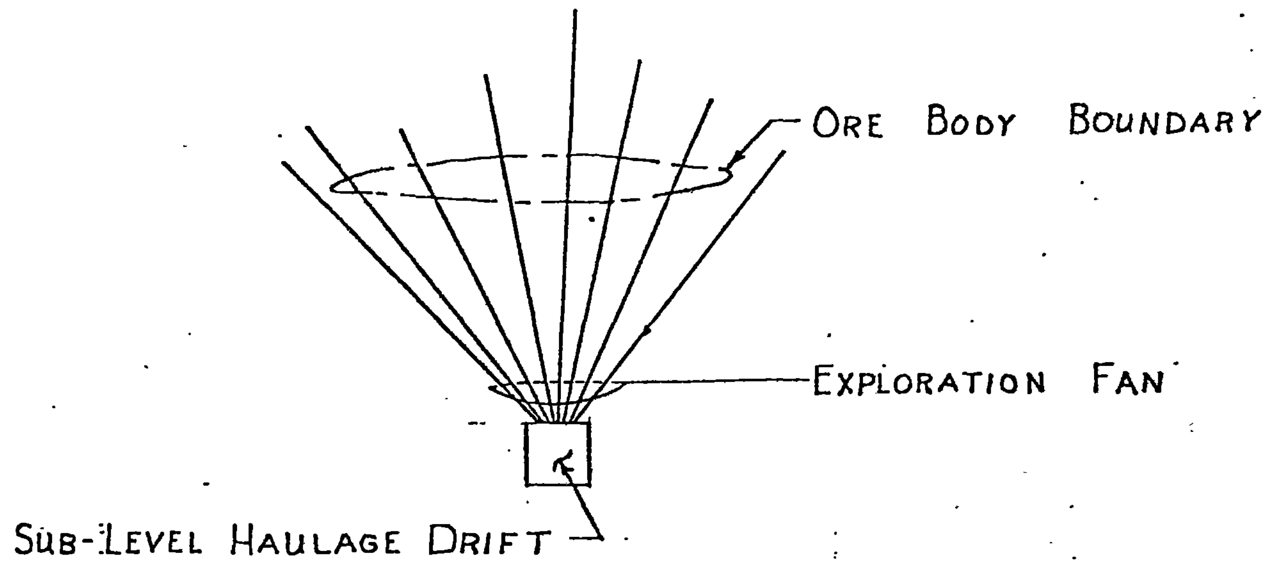


Figure 1. Mine Level Haulage
Plan View: No Scale



Section A-A. (No Scale)



SECTION: B-B. (NO SCALE)

REPORT OF INSPECTION
of
April 28, 1976

The Anaconda Company
Laguna Tribal Lease 4
Jackpile-Paguate Minesite

Laguna Indian Reservation
Valencia County, New Mexico

U. S. Department of the Interior
Geological Survey
Conservation Division
P. O. Box 1716
Carlsbad, New Mexico 88220

by
Dale C. Jones
Mining Engineer
May 19, 1976

The Anaconda Company's Laguna Tribal Lease 4 (Jackpile-Paguate Mining Lease) was inspected April 28, 1976, by the writer in the company of Clifford M. Gibbs, Superintendent of Underground Operations. The purpose of the inspection was the on-site examination of the area that would be affected by the company's proposed P-15 and P-17 Mines in order to assess the potential environmental impacts of the proposed mines. The mining and reclamation plan for the two uranium mines was submitted to the Area Mining Supervisor, SRMA, March 18, 1976.

The involved lands are located in Sections 9 and 16, Township 10 North, Range 5 West, N.M.P.M., on the Laguna Indian Reservation in Valencia County, New Mexico. The proposed mines would be within an area of about 1 square mile approximately 2 miles southeast of the company's currently producing P-10 Mine. The small Indian village of Paguate is located about 2 1/2 miles north of the area, and the Laguna Pueblo is about 5 miles to the south.

The proposed locations of the two mines, are situated on the steeply sloping northeast flank of Black Rim Mesa where elevations range from 6000 to 6900 feet above sea level. The vegetation in the area consists primarily of a moderate cover of native grasses and juniper trees with occurrences of cacti, mostly cholla, and the surface is covered liberally with basalt boulders. A few northeast trending dry washes channel surface runoff during times of significant precipitation toward the Rio Paguate which flows southward toward the Rio San Jose. The land surface has been impressed by many drill sites and access roads that were constructed by The Anaconda Company during its exploration operations.

Wildlife in the area is probably confined to birds and small mammals typical of this part of New Mexico. According to Mr. Gibbs, a small herd of almost wild horses that belong to the Laguna Indians roam the area. Cattle do not graze in the area.

The P-15 and P-17 Mines would be underground uranium operations developed through vertical shafts 625 and 575 feet deep respectively. Mining of the ore bodies, which are located in the Jackpile sandstone unit in the upper part of the Brushy Basin Member of the Jurassic Morrison Formation, would be by conventional modified room-and-pillar stoping methods with sublevel track haulage. Ore production at both mines would begin in 1978. The P-15 Mine would have a life of about 7 years with a maximum production rate of about 500 TPD (tons of ore per day); the P-17 Mine would have a life of approximately 8 years and a maximum production rate of about 700 TPD.

During the inspection tour, the writer examined the surface equipment associated with two existing ventilation boreholes for the P-10 Mine and the drilling operations on a vent hole currently being developed for the P-10 Mine. The writer also briefly toured the village of Paguate.

No violations of safety rules or lease terms were observed.

Dale C. Jones
Mining Engineer

Orig to: Superintendent, BIA, Southern Pueblos Agency
cc: Governor, Pueblo of Laguna
cc: Chief, Branch of Mining Operations through Regional Conservation Manager
cc: Files

United States Department of the Interior

GEOLOGICAL SURVEY

P.O. BOX 1716

CARLSBAD, NEW MEXICO 88220

IN REPLY
REFER TO:

March 19, 1976

COUNTY CLERK

Mrs. Pat I. Heth

Valencia County Court House

Las Lunas, New Mexico 87031

Dear Mrs. Heth:

Enclosed is a public notice listing this week's new mining plans and/or significant revisions to previous mining plans. We suggest these notices be posted in some prominent place for public viewing and that local news media be advised of their availability in your office.

Sincerely yours,

Dale C. Jones

Dale C. Jones
Mining Engineer
for R. S. Fulton
Area Mining Supervisor

NEW MEXICO PLANS OR MAJOR MODIFICATIONS OF EXISTING PLANS
SUBMITTED FOR APPROVAL

Release Date March 19, 1976

Date	Lessee or Operator	Lease Number	Location	County	State
3/18/76	The Anaconda Company	Laguna Tribal Uranium Lease No. 4	T10N, R5W, NMPM Sec. 3, S½S½NW¼, SW¼ Sec. 4, S½S½N½, S½ Sec. 5, SE¼NW¼, Lots 1 & 2, S½NE¼, E½SW¼, SE¼ Sec. 8, NE¼NW¼, N½N½SE¼NW¼, NE¼, NE¼SE¼, E½W½SE¼SE¼, E½SE¼SE¼ Sec. 9, All Sec. 10, NW¼, N½SW¼, N½S½SW¼ Sec. 16, N½	Valencia,	New Mexico

A copy of the plan may be reviewed at the office location given below. Pertinent comments are solicited from anyone affected by this proposal. Such comments should be filed within 30 days from the date of this release. Response timely filed will be considered in the preparation of the environmental analysis. Responses should be addressed to the mining supervisor at the following address:

Area Mining Supervisor
Conservation Division
U. S. Geological Survey
Federal Building
114 South Halagueno
P. O. Box 1716
Carlsbad, New Mexico 88220

APPENDIX XII

Representative Fauna and Flora of the Jackpile-Paguate Mine Area

APPENDIX A

REPRESENTATIVE PLANT SPECIES AND VERTEBRATES OF THE JACKPILE-PAGUATE MINE AREA

PLANTS

Pinaceae Pine Family

Pinus edulis - Pinyon Pine

Cupressaceae Cypress Family

Juniperus monospermae - One-seed Juniper
Juniperus scopulorum - Rocky Mountain Juniper

Gramineae Grass Family

Agropyron trachycaulus - Slender Wheat Grass
Aristida divaricata - Poverty Three-Awn
Aristida longiseta - Red Three-Awn
Bouteloua curtipendula - Side Oats Grama
Bouteloua eriopoda - Black Grama
Bouteloua gracilis - Blue Grama
Bouteloua hirsuta - Hairy Grama
Danthonia intermedia - Oat Grass
Hilaria jamesii - Galleta
Hordium jubatum - Fox-tail Barley
Muhlenbergia torreyi - Ring Grass Muhly
Oryzopsis hymenoides - Rice Grass
Poa pratense - Kentucky Blue Grass
Sitanion hystrix - Squirrel-tail Grass
Sporobolus airoides - Alkali-Sacaton
Sporobolus cryptandrus - Sand Drop Seed
Stipa comata - Needle Grass

Commelinaceae Spiderwort Family

Tradescantia pinetorium - Spiderwort

Liliaceae Lily Family

Yucca baccata - Blue Yucca
Yucca glauca
Nolina microcarpa - Beargrass

Salicaeae Willow Family

Populus fremontii - Cottonwood
Salix irrorata - Willow

Fagaceae Beech Family

Quercus gambelii - Gambel Oak
Quercus turbinella - Shrub Live Oak

Polygonaceae Buckwheat Family

Eriogonum delflexum - Skeletonweed
Eriogonum racemosum - Red-root Eriogonum

Amaranthaceae Amaranth Family

Amaranthus palmeri - Careless-Weed

Chenopodiaceae Goose Foot Family

Atriplex canescens - Four-wing Saltbush
Chenopodium album - Lambs-Quarters
Chenopodium desicatum - Narrowleaf Goosefoot
Eurotia lanata - Winter-fat
Salsola kali - Russian Thistle
Sarcabatus vermiculatus - Greesewood
- Narrowleaf Goosefoot

Geraniaceae Geranium Family

Geranium fremontii - Cranebill

Anacardiaceae Cashew Family

Rhus trilobata - Skunk-Bush

Rhamnaceae Buck-Thorn Family

Ceanothus fendleri - Buck-brush

Malvaceae Mallow Family

Sphaeralcea coccinea - Globe Mallow
Sphaeralcea fendleri - Globe Mallow

Cactaceae Cactus Family

Opuntia imbricata - Cholla
Opuntia polyacantha - Prickly Pear

Onagraceae Evening Primrose Family

Oenothera caespitosa - Evening Primrose

Convolvulaceae Convolvuvus Family

Evolvulus pilosus

Polemoniaceae Phlox Family

Gilia multiflora

Boraginaceae Borage Family

Cryptantha jamesii
Lappula florabunda - Stick-seed

Solanaceae Potato Family

Lycium pallidum - Wolf-Berry
Physalis fendleri - Ground-Cherry

Loasaceae

Mentzelia pumila - Stickleaf

Nyctaginaceae Four-O'Clock Family

Mirabilis multiflora- Four O'Clock

Papaveraceae Poppy Family

Argemone platyceras - Prickly-Poppy

Cruciferae Mustard Family

Capsella Bursa-pastoris - Shepherds Purse
Descurainia pinnata - Tansy Mustard
Erysimum asperum - Wallflower
Lepidium medium - Pepper Grass
Lesquerella fendleri

Capparidaceae Caper Family

Cleome serrulata - Rocky Mountain Bee Plant

Rosaceae Rose Family

Cercocarpus montanus - Alder-Leaf Mountain Mohogany
Cowania stansburiana - Cliff-Rose
Fallugia paradoxa - Apache-Plume
Holodiscus dumosus- Rock-Spiraea
Potentialla hippiana - Cinquefoil
Rubus strigosus - Wild Raspberry

Leguminosae Pea Family

Astragalus spp. - Milk-Vetch
Calliandra reticulata - False Mesquite

Scrophulariaceae Figwort Family

Castilleja integra - Paintbrush
Penstemon jamesii - Beardtonque
Verbascum thapsus - Mullein

Plantaginaceae Plantain Family

Plantago virginica - Indian Wheat

Compositae Sunflower Family

Achillea lanulosa - Western Yarrow
Artemisia tordentata - Sagebrush
Artemisia frigida - Estafiata
Aster hirtifolius - Baby Aster
Bahia disseeta - Yellow Ragweed
Brickellia spp.
Chrysothamnus nauseosus - Rabbit-Brush
Cirsium pulchellum - Thistle
Erigeron divergens - Wild Daisy
Gutierrezia sarothrae - Snakeweed
Haplopappus gracilis - Goldenweed
Helianthus annuus - Sunflower
Hymenoxys acaulis - Pinque
Hymenoxys richardsonii - Pinque
Senecio multicapitatus - Groundsel
Senecio vulgaris - Groundsel

VERTEBRATES

AMPHIBIANS:

Western Spadefoot Toad - Scaphiopus hammondi
Great Basin Spadefoot - S. intermontanus
Plains Spadefoot - S. bombrifrons
Woodhouse Toad - Bufo woodhousei
Lepoard Frog - Rana pipiens

REPTILES:

Lesser Earless Lizard - Holbrookia maculata
Collared Lizard - Crotaphytus collaris
Eastern Fence Lizard - Sceloporus undulatus
Side-blotched Lizard - Uta stansburiana
Tree Lizard - Urosaurus ornatus
Short-horned Lizard - Phrynosoma douglassi
Great Plains Skink - Eumeces obsoletus
Plateau Whiptail - Cnemidophorus velox
Striped Whipsnake - Masticophis taeniatus
Moutain Patch-nosed Snake - Salvadora grahamiae
Gopher Snake - Pituophis melanoleucus
New Mexico Milk Snake - Lampropeltis triangulum
Wandering Garter Snake - Thamnophis elegans
Black-necked Garter Snake - T. cyrtopsis
Night Snake - Hypsiglena torquata
Western Diamondback Rattlesnade - Crotalus atrox
Black-tailed Rattlesnake - C. molossus
Western Rattlesnake - C. viridis

AQUATIC BIRDS:

Pied-billed Grebe - Podilymbus podiceps

DUCKS:

Mallard - Anas platyrhynchos
Mexican Duck - Anas diazi
Gadwell - Anas strepera
Pintail - Anas acuta
Green-winged Teal - Anas crecca
Blue-winged Teal - Anas discors
Cinnamon Teal - Anas cyanoptera
American Widgeon - Anas americana
Northern Shoveler - Anas clypeata
Ruddy Duck - Oxyura jamaicensis

HAWKS AND ALLIES:

Turkey Vulture - _Cathartes aura_
Sharp-shined Hawk - _Accipiter striatus_
Cooper Hawk - _Accipiter cooperii_
Red-tailed Hawk - _Buteo jamaicensis_
Swainson Hawk - _Buteo swainsoni_
Rough-legged Hawk - _Buteo lagopus_
Ferruginous Hawk - _Buteo regalis_
Golden Eagle - _Aquila chrysaetos_
Marsh Hawk - _Circus cyaneus_
Peregrine Falcon- _Falco peregrinus_
Prairie Falcon - _Falco mexicanus_
Pigeon Hawk - _Falco columbarius_
American Kestrel - _Falco sparverius_

QUAILS AND ALLIES:

Scaled Quail - _Callipepla squamata_
Quail - _Cyrtonyx montezumae_

CRANES AND RAILS:

American Coot - _Fulica americana_

SHOREBIRDS:

Killdeer - _Charadrius vociferus_
Mountain Plover - _Charadrius montana_
Common Snipe - _Capella gallinago_
Spotted Sandpiper - _Actitis macularia_
Western Sandpiper - _Calidris mauri_

DOVES:

Rock Dove - _Columba livia_
Mourninig Dove - _Zeuaida macroura_

CUCKOOS:

Yellow-billed Cuckoo - _Coccyzus americanus_
Roadrunner - _Geococcyx californianus_

OWLS:

Barn Owl - _Tyto alba_
Screech Owl - _Otus asio_
Flammulated Owl - _Otus flammeolus_
Great Horned Owl - _Bubo virginianus_
Burrowing Owl - _Speotyto cunicularia_

NIGHTHAWKS:

Common Nighthawk - Chordeiles minor

SWIFTS AND HUMMINGBIRDS:

White-throated Swift - Aeronautes saxatalis
Broad-tailed Hummingbird - Selasphorus platycercus
Rufous Hummingbird - Selasphorus rufus

KINGFISHERS AND WOODPECKERS:

Common Flicker - Colaptes auratus
Lewis Woodpecker - Asyndesmus lewis
Hairy Woodpecker - Dendrocopus villosus

PERCHING BIRDS:

Western Kingbird - Tyrannus verticalis
Cassin Kingbird - Tyrannus vociferans
Black Phoebe - Sayornis nigricans
Say Phoebe - Sayornis saya
Western Flycatcher - Empidonax difficilis
Western Wood Pewee - Contopus sordidulus
Olive-sided Flycatcher - Nuttallornis borealis
Horned Lark - Eremophila alpestris
Violet-Green Swallow - Tachycineta thalassina
Bank Swallow - Riparia riparia
Rough-winged Swallow - Stelgidopteryx ruficollis
Barn Swallow - Hirundo rustica
Cliff Swallow - Petrochelidon pyrrhonota
Scrub Jay - Aphelocoma coerulescens
Common Raven - Corvus corax
Pinyon Jay - Gymnorhinus cyanocephalus
Clark Nutcracker - Nucifraga columbiana
Mountain Chickadee - Parus gambeli
Plain titmouse - Parus inornatus
Common Bushtit - Psaltriparus minimus
White-breasted Nuthatch - Sitta carolinensis
Bewick Wren - Thryomanes bewickii
Canyon Wren- Catherpes mexicanus
Rock Wren - Salpinctes obsoletus
Mockingbird - Mimus polyglottos
Sage Thrasher - Oreoscoptes montanus
Robin - Turdus migratorius
Hermit Thrush - Hylocichla guttata
Western Bluebird - Sialia mexicana
Mountain Bluebird - Sialia currucoides
Townsend Solitaire - Myadestes townsendi
Ruby-crowned Kinglet - Regulus calendula
Water Pipit - Anthus spinoletta
Loggerhead Shrike - Lanius ludovicianus

Starling - Sturnus vulgaris
Solitary Vireo - Vireo solitarius
Yellow Warbler - Dendroica petechia
Warbler - Dendroica coronata
Black-throated Gray Warbler - Dendroica nigrescens
Townsend Warbler - Dendroica townsendi
MacGillivray Warbler - Oporornis tolmiei
Yellow-breasted Chat - Icteria virens
Wilson Warbler - Wilsonia pusilla
House Sparrow - Passer domesticus
Western Meadowlark - Sturnella neglecta
Yellow-headed Blackbird - Xanthocephalus xanthocephalus
Red-winged Blackbird - Agelaius phoeniceus
Northern Oriole - Icterus galbula
Brown-headed Cowbird - Molothrus ater
Western Tanager - Piranga ludoviciana
Black-headed Grosbeak - Pheucticus melanocephalus
Cassin Finch - Carpodacus cassinii
House Finch - Carpodacus mexicanus
Pine Siskin - Spinus pinus
American Goldfinch - Spinus tristis
Green-tailed Towhee - Chlorura chlorura
Rufous-sided Towhee - Pipilo erythrophthalmus
Brown Towhee - Pipilo fuscus
Lark Bunting - Calamospiza melanocorys
Vesper Sparrow - Pooecetes gramineus
Lark Sparrow - Chondestes grammacus
Sage Sparrow - Amphispiza belli
Dark-eyed Junco - Junco hyemalis
Gray-headed Junco - Junco caniceps
Chipping Sparrow - Spizella passerina
Brewer Sparrow - Spizella breweri
White-crowned Sparrow - Zonotrichia leucophrys
Song Sparrow - Melospiza melodia

SHREW:

Vagrant Shrew - Sorex vagrans

BATS:

Arizona Myotis - Myotis lucifugus
Long-eared Myotis - Myotis evotis
Long-legged Myotis - Myotis volans
Small-footed Myotis - Myotis subulatus
Silver-haired Bat - Lasionycteris noctivagans
Western Pipistrel - Pipistrellus hesperus
Big Brown Bat - Eptesicus fuscus
Hoary Bat - Lasiurus cinereus
Mexican Freetail Bat - Tadarida brasiliensis

CARNIVORES:

Longtail Weasel - _Mustela frenata_
Badger - _Taxidea taxus_
Striped Skunk - _Mephitis mephitis_
Coyote - _Canis latrans_
Gray Fox - _Urocyon cinereoargenteus_
Bobcat - _Lynx rufus_

RODENTS:

Whitetail Prairie Dog - _Cynomys gunnisoni_
Rock Squirrel - _Citellus variegatus_
Spotted Ground Squirrel - _Citellus spilosoma_
Whitetail Antelope Squirrel - _Ammospermophilus leucurus_
Least Chipmunk - _Eutamias minimus_
Cliff Chipmunk - _Eutamias dorsalis_
Valley Pocket Gopher - _Thomomys bottae_
Silky Pocket Mouse - _Perognathus flavus_
Apache Pocket Mouse - _Perognathus apache_
Bannertail Kangaroo Rat - _Dipodomys spectabilis_
Ord Kangaroo Rat - _Dipodomys ordi_
Western Harvest Mouse - _Reithrodontomys megalotis_
White-footed Mouse - _Peromyscus leucopus_
Deer Mouse - _Peromyscus maniculatus_
Brush Mouse - _Peromyscus boylei_
Pinyon Mouse - _Peromyscus truei_
Rock Mouse - _Peromyscus difficilis_
Northern Grasshopper Mouse - _Onychomys leucogaster_
Whitethroat Woodrat - _Neotoma albigula_
Mexican Woodrat - _Neotoma mexicana_
House Mouse - _Mus musculus_
Porcupine - _Erethizon dorsatum_

RABBITS:

Blacktail Jackrabbit - _Lepus californicus_
Desert Cottontail - _Sylvilagus auduboni_

UNGULATES:

Mule Deer - _Odocoileus hemionus_

2.1.6 Flora and Fauna

2.1.6.1 Biotic Communities

Flora and fauna form interrelated assemblages that function as cohesive biological units, or biotic communities, which can be described by structure and species composition. Although no two natural communities are identical in all of their characteristics, they are, for convenience and orderly reference, identified on the basis of major features. The floral composition and structure are the most common characteristics used in naming and delineating communities, but the faunal composition is an integral part.

Two major communities, the Grama-Galleta Steppe and the Juniper-Pinyon Woodland, overlap in northwestern New Mexico and adjoining plateau areas (Kuchler, 1964), forming an extensive transition belt that includes much of Valencia County and more specifically, the area where the Jackpile-Paguate mine is located.

The steppe is characterized by perennial grasses. Among these grasses, blue grama, galleta and alkali sacaton provide a nutritious forage resource which in recent times has been exploited by the cattle industry. Grazing has contributed to vegetative change and deterioration of perennial grasses and juniper now occupies former grassland sites (Benson and Darrow 1954; Jameson, 1962).

In the mine area, pinyon pine does not represent a major element of the juniper-pinyon woodland. Here juniper, tolerating dryer sites than does pinyon pine, dominates and is particularly abundant on mesas and rocky slopes. At the 5800 to 6400 foot elevations of the Jackpile-Paguate mine area, available moisture is sufficient for the perpetuation of Rocky Mountain and one-seeded juniper.

The riparian woodland is an important minor community bordering the Rio Paguate and, to a lesser extent, the Rio Moquino, in the mine area. The dominant species here is salt cedar, an exotic that has invaded watercourses where disturbance has occurred (Horton, 1966). The native dominant species, cottonwood and willow, are scattered among the salt cedar stands.

The fauna inhabiting the area are distributed by microhabitat preference with the result that many species occupy more than one community. Arboreal vertebrates, for instance, may be found in both riparian and juniper woodlands, and, since the juniper woodlands and grasslands form an ecotone, many of the cursorial and fossorial animals range throughout the area.

Checklists of representative plants and animals which would be expected to occur in the mine area are presented in Appendix A.

These lists have been compiled on the basis of field observations and distributional data in Bailey (1931), Benson and Darrow (1954), Castetter (1956), Gehlbach (1965), Hubbard (1970), Kearney and Pebbles (1951), Ligon (1961), and Stebbins (1966).

2.1.6.2 Biological Sampling Program

A limited biological field investigation was conducted during a week-long period in July, 1975. A basic objective of this investigation was to describe the floral and faunal characteristics of the mine area; this was approached by obtaining information relating to the kinds and relative abundance of plant and animal species present at sites which were representative of the existing topographic and phsiographic variability. A second objective was to provide insight into the reclamation potential of dump sites; to this end, since talus slopes and dump sites have certain environmental features in common, both were sampled for comparative biotic data.

Vegetation was sampled using 50 foot line intercept and wandering quarter methods (Phillips, 1959 and Cantana, 1963, respectively). The following sites were sampled by the line intercept method:

1. Mesa: Southwest corner of Gavilan Mesa, 6400 foot elevation, Section 35, T11N, R5W
2. Flats: Area near the Rio Moquino, 6000 foot elevation, Section 34, T11N, R5W
3. Riparian: Rio Paquate along southern border of the Jackpile mine, 5850 foot elevation, Section 2, T10N, R5W
4. Slopes: North-facing slope of North Oak Creek Canyon Mesa, 6000 foot elevation, Section 3-34 line, T10-11N, R5W. South-facing slope of North Oak Creek Canyon Mesa, 6000 foot elevation, Section 2, T10N, R5W
5. Dump: North Dump, 5950 foot elevation, Section 34, T11N, R5W

At the North Dump, vegetation was sampled by three line intercepts, one of which was over a recently disturbed surface, one over an undisturbed surface, and the third over an older re-seeded surface where salt cedar and shrubs were present.

The wandering quarter method was used to sample juniper trees at the mesa and slope sites. Fifty-four trees were sampled at the mesa site and fifty were sampled on the north-facing slope site.

Small mammals were sampled at the flats, riparian, north-facing slope and dump sites using a line of 30 Sherman live-traps spaced at 45 foot intervals at each site. Traps were set on two consecutive nights, July 23 and 24, 1975.

Birds, mammals, amphibians and reptiles were observed and recorded during general reconnaissance each day in the field. All species sightings and signs were noted.

2.1.6.3 Characteristics of Sites Sampled

No unique environmental area was identified at the Jackpile-Paguate mine. All species encountered are representatives of major communities and widespread habitants which exist throughout much of northwestern New Mexico. The different sample sites did exhibit significant variations in vegetative composition and abundance. This data is summarized in Tables 2.1-19 and 2.1-20.

TABLE 2.1-19

PERCENTAGE AERIAL (FOLIAR) COVER AND BARE GROUND AT FIVE SAMPLE SITES AT THE JACKPILE-PAGUATE MINE, JULY 1975

	Percent Cover				
Sample Site*	Mesa	Flats	Riparian	Slopes	Dump
Number of 50 foot line Intercepts	5	5	5	3	3
Bare ground	66	44	36	69	63
Trees	0	0	16	6	0
Shrubs	10	12	14	7	1
Forbs	3	28	8	2	27
Grasses	21	16	26	16	9

*Refer to Section 2.1.6.2 for locations of sites

TABLE 2.1-20

PERCENTAGE PLANT SPECIES COMPOSITION AT FIVE SAMPLE SITES AT THE JACKPILE-PAGUATE MINE, JULY, 1975

	Percent Composition				
Sample Sites*	Mesa	Flats	Riparian	Slopes	Dump
One-seeded Juniper	–	–	–	2	–
Slender Wheat Grass	–	–	35	–	–
Aristida sp.	32	–	–	–	–
Red Three-Awn	–	5	1	1	20
Side Oats Grama	–	–	–	16	–
Blue Grama	8	2	–	45	–
Oatgrass	–	–	1	–	–
Galleta	26	15	1	7	–
Barley	–	–	1	–	–
Ring Muhley	–	5	–	2	3
Rice Grass	–	3	–	–	1
Squirrel-tail Grass	–	1	1	–	–
Alkali Sacaton	–	8	17	–	1
Needle Grass	–	–	–	1	–
Yucca	< 1	–	–	2	–
Cottonwood	–	–	1	–	–
Skeletonweed	–	–	–	–	46
Red-root Eriogonum	–	–	–	3	–
Four-O'Clock	< 1	–	–	–	–
Four-wing Saltbush	–	–	1	–	1
Lamb's Quarter	< 1	–	–	–	–
Narrowleaf Goosefoot	–	4	1	–	1
Russian Thistle	–	28	2	–	22
Flax	–	1	–	–	–
Purolane	–	–	–	1	–
Squawbush	–	–	–	2	–
Salt Cedar	–	–	4	–	–
Globe Mallow	–	–	1	–	–
Stickleaf	–	–	–	–	1
Prickly Pear Cactus	< 1	< 1	–	1	–
Blue Gilia	–	–	1	–	–
Wolf-berry	< 1	–	–	–	–
Purple Nightshade	–	6	–	–	–
Groundcherry	–	< 1	–	–	–
Bladderpod	1	–	–	–	–
Spectacle Pod	< 1	1	–	–	–
Yellow Mustard	5	–	–	–	–
Fake Mesquite	–	–	–	1	–
White Sweetclover	–	< 1	7	–	–
Rocky Mountain Bee Plant	–	–	1	–	–
Big Sagebrush	7	–	–	1	–
Estafiata	–	–	–	9	–
Baby Aster	6	< 1	–	3	–
Yellow Ragweed	–	–	–	–	2
Rabbit-brush	–	< 1	7	–	–
Thistle	–	< 1	–	–	–

TABLE 2.1-20 (Cont'd)

Sample Sites	1	2	3	4	5
Horseweed	-	2	5	-	-
Snakeweed	11	12	1	5	1
Goldenweed	-	1	-	-	-
Sunflower	-	-	2	-	-
Pinque	1	1	-	-	-
Psilotrophe	-	1	-	-	-
Groundsel	-	<1	2	-	-
Cocklebur	-	7	4	-	-
Total Species	15	25	22	18	11

*Refer to Section 2.1.6.2 for locations of sites

The mesa site exhibits both juniper and grassland vegetation. One-seeded juniper forms pure stands at this site with a density of 12 trees per acre. Sixty-six percent of the surface is bare ground. Shrubs represent ten percent of the cover and grasses 21 percent. Galleta and Aristida sp. compose a major portion of the grasses and snakeweed, sagebrush, and aster are common shrubs and forbs.

The flats, or Moquino site, is predominantly a grass and shrub area. Junipers here are scattered and restricted to rocky locales. Although more surface is covered and more species are represented than at the mesa site, most are species of forbs and shrubs which are indicators of disturbance. It is likely that this area has been heavily grazed in the past.

The riparian site has the highest percentage of total cover and grass of the five sites sampled. The common grass species are slender wheat grass and alkali sacaton. Rabbitbrush is the dominant shrub and sweetclover shares dominance with horseweed among the forbs. Salt cedar and cocklebur, both indicators of disturbed riparian woodland, each represent four percent of the species composition. Cottonwood, which is a native climax dominant of riparian woodland, represents only one percent of the composition. In fact, only a few cottonwoods remain along the Rio Paguate south of the mine to the mine property boundary.

The slope site includes both north- and south-facing slopes. Juniper was sampled only on the north-facing slope where the density was 76 trees per acre or about seven times greater than on the mesa top. Talus prevents establishment of vegetative cover to the extent that 69 percent of the surface sampled was bare ground or rock. Grasses comprise 16 percent of the cover, a percentage equal to that of the flats site. Blue grama, side-oats grama and galleta grasses, all important range species, dominate the grass cover. Snakeweed and red-root eriogonum are the main shrubs, but snakeweed is not as common as on the mesa and flats sites. Among the natural sites sampled, this is perhaps the least disturbed.

The dump site is of particular interest because it directly involves past and present mining activity. Unlike the natural sites, nearly all the vegetative cover is represented by annuals. Skeletonweed, Russian thistle, and other forbs outweigh grasses and shrubs in importance. Red three-awn grass is the most common grass but is mainly restricted to the older reseeded portion of the dump.

Closer examination of the dump site reveals that the time since disturbance has great bearing on the composition and amount of vegetative cover (Table 2.1-21). The data indicates a successional trend in which Russian thistle and skeletonweed

TABLE 2.1-21

PERCENTAGE AERIAL (FOLIAR) COVER AND PERCENTAGE SPECIES COMPOSITION ALONG THREE 50 FOOT LINE INTERCEPTS AT THE NORTH DUMP, JACKPILE-PAGUATE MINE, JULY, 1975

	Percent Cover		
	1*	2*	3*
Bare Ground	82	48	60
Shrubs	0	0	4
Forbs	17	52	11
Grasses	1	0	25
Species	**Percent Composition**		
Red Three-Awn	-	-	45
Ring Muhley	-	-	8
Rice Grass	-	-	2
Alkali Sacaton	6	-	-
Skeletonweed	-	76	29
Four-wing Saltbush	-	-	2
Narrowleaf Goosefoot	-	-	2
Russian Thistle	94	20	-
Stickleaf	-	4	6
Yellow Ragweed	-	-	4
Snakeweed	-	-	2
Total No. of Species	2	3	9

* 1: New - area recently established;
2: Intermediate - area where dump has been left undisturbed;
3: Old - area reseeded and undisturbed for about seven years.

are replaced by a more diverse array of grasses, forbs and shrubs. Whether the grasses originated from seeding programs or are colonizers from adjacent natural stock cannot be determined, but their success, and especially that of red three-awn, seems related to swells and catchment locales. In one four-foot depression at the north dump, a fifteen foot salt cedar grows in the trough, Purple nightshade, narrowleaf goosefoot, horseweed and alkali sacaton share this depression with red three-awn, stickleaf, fourwing saltbush, and skeletonweed growing on the slopes. Conversely, vegetative cover seems to deteriorate where the dump surface forms rises and small ridges. It appears that the slight depressions on the older dump area may serve a dual role by modifying wind erosion and desiccation as well as acting as reservoirs for water catchment and accumulation of organic material.

The slopes of the dump are physiographically similar to the natural talus slopes of the mine area. On the latter the sloping surface is stabilized by scree. Riprap on the dump slope serves the same purpose and stability is a function of boulder size and talus mass. Presently, the dump slopes support nearly pure stands of Russian thistle particularly in the newer sections. Where talus covers finer-grained soils on the dump slopes, Russian thistle abounds, and gullying is not as evident as elsewhere.

Vertebrates recorded at the mine sites are listed in Tables 2.1-22 and 2.1-23. Small mammals trapped at four sample sites show the expected species habitat preferences. The rock-outcrop dwellers, namely whitetail antelope squirrels, cliff chipmunks, and Mexican woodrats, were caught at the slope site. White-footed mice and silky pocket mice are grassland dwellers (Burt and Grossenheider, 1964) whereas deer mice are ubiquitous and occupy a variety of habitats, including disturbed areas (Turkowski and Reynolds 1970). Two deer mice were the only mammals captured at the dump. Rock squirrels, which are rock-outcrop inhabitants, were trapped only at the riparian site. However, all were immature and they may have been moving to new areas.

2.1.6.4 Endangered and Threatened Species

Endangered and threatened species include those considered by the Endangered Species Act of 1973 to be in jeopardy of extinction. Endangered species are those in danger of extinction throughout all or a significant portion of their range while threatened species are those which are likely to become endangered within the foreseeable future.

The black-footed ferret, southern bald eagle, American peregrine falcon and the Mexican duck are the only species included in the U.S. List of Endangered Fauna (Office of Endangered Species, 1974) which range into Valencia County, New Mexico.

TABLE 2.1-22

SMALL MAMMALS TRAPPED AT FOUR SITES (HABITATS) AT THE JACKPILE-PAGUATE MINE, JULY, 1975

	Habitat*				
	Flats	Riparian	Slope	Dump	Total
Trap Nights	60	60	60	60	240
Total Species	3	2	3	1	7
Total Captures	7	6	3	2	18
Trap Nights per Captures	9	10	20	30	13

Species	Captures	% Composition	Habitat
Rock Squirrel	4	22	Riparian
Whitetail Antelope Squirrel	1	6	Slope
Cliff Chipmunk	1	6	Slope
Silky Pocket Mouse	1	6	Flats
Deer Mouse	8	44	Flats, Dump Riparian
White-footed Mouse	2	11	Flats
Mexican Woodrat	1	6	Slope

*Habitats represented at the four sample sites are the same as those given in Table 2.1-19 and text.

TABLE 2.1-23

VERTEBRATE SPECIES RECORDED AT THE JACKPILE-PAGUATE MINE, JULY, 1975

AMPHIBIANS:

Plains Spadefoot (Scaphiopus bombrifrons)
Woodhouse Toad (Bufo woodhousei)

REPTILES:

Lesser Earless Lizard (Holbrookia maculata)
Eastern Fence Lizard (Sceloporus undulatus)
Side-blotched Lizard (Uta stansburiana)
Short-horned Lizard (Phrynosoma douglassi)
Plateau Whiptail (Cnemidophorus velox)
Gopher Snake (Pituophis melanoleucus)
Western Rattlesnake (Crotalus viridis)

HAWKS AND ALLIES:

Turkey Vulture (Cathartes aura)
Red-tailed Hawk (Buteo jamaicensis)
American Kestrel (Falco sparverius)

SHOREBIRDS:

Killdeer (Charadrius vociferus)

DOVES:

Rock Dove (Columba livia)
Mourning Dove (Zeuaida macroura)

NIGHTHAWKS:

Common Nighthawk (Chordeiles minor)

PERCHING BIRDS:

Western Kingbird (Tyrannus verticalis)
Black Phoebe (Sayornis nigricans)
Say Phoebe (Sayornis saya)
Western Wood Pewee (Contopus sordidulus)
Horned Lark (Eremophila alpestris)
Barn Swallow (Hirundo rustica)
Cliff Swallow (Petrochelidon pyrrhonota)

PERCHING BIRDS CONT'D:

Scrub Jay (Aphelocoma coerulescens)
Common Raven (Corvus corax)
Pinyon Jay (Gymnorhinus cyanocephalus)
Rock Wren (Salpinctes obsoletus)
Mockingbird (Mimus polyglottos)
Robin (Turdus migratorius)
Loggerhead Shrike (Lanius ludovicianus)
Starling (Sturnus vulgaris)
Yellow-breasted Chat (Icteria virens)
House Sparrow (Passer domesticus)
Western Meadowlark (Sturnella neglecta)
Red-winged Blackbird (Agelaius phoeniceus)
House Finch (Carpodacus mexicanus)
Brown Towhee (Pipilo fuscus)
Lark Sparrow (Chondestes grammacus)
Brewer Sparrow (Spizella breweri)

CARNIVORES:

Badger (Taxidea taxus)
Coyote (Canis latrans)

RODENTS:

Whitetail Prairie Dog (Cynomys gunnisoni)
Rock Squirrel (Citellus variegatus)
Whitetail Antelope Squirrel (Ammospermophilus leucurus)
Cliff Chipmunk (Eutamias dorsalis)
Valley Pocket Gopher (Thomomys bottae)
Silky Pocket Mouse (Perognathus flavus)
Ord Kangaroo Rat (Dipodomys ordi)
White-footed Mouse (Peromyscus leucopus)
Deer Mouse (Peromyscus maniculatus)
Mexican Woodrat (Neotoma mexicana)
Porcupine (Erethizon dorsatum)

RABBITS:

Blacktail Jackrabbit (Lepus californicus)
Desert Cottontail (Sylvilagus auduboni)

There are no recent records of black-footed ferrets in northwestern New Mexico. Considering the fact that this species more readily preys on black-tailed prairie dogs rather than upon white-tailed prairie dogs which do occur in the mine area, the presence of these carnivore is unlikely.

The southern bald eagle has been sighted at Mt. Taylor some 30 miles west of the Jackpile-Paguate mine. Mr. Elrod Leany (The Anaconda Company, personal communication) reports seeing adults and immature bald eagles in the winter of 1973 at the Bluewater Mill. Although there are no critical niche features within the mine area, it is almost certain that this endangered species is a transient in the area.

Peregrine falcon are sporadic transients throughout northern New Mexico, and their range includes the mine area. Their presence at the mine area is unlikely and cannot be considered more than accidental.

The Mexican duck, like the bald eagle, has been reported from the general area. Sightings have been made at Burford Lake, Rio Arriba County (Ligon, 1961; Huey and Travis, 1961) and as near as Acomita, Valencia County (Hubbard, 1970). This species tends to range along the Rio Grande Valley and southward, and the sightings noted here were made at marsh areas which are not found in the mine area.

The Office of Endangered Species (1973) lists several species on the list of Threatened Species whose ranges include the Jackpile-Paguate Mine area. These include the prairie falcon, spotted owl, burrowing owl and spotted bat. It is unlikely that any of these, with the possible exception of the borrowing owl, would be more than a transient in habitats of the mine area.

2.1.7 Archaeological and Historical Sites

Archaeological clearance surveys were conducted for this Mining and Reclamation Plan in November 1975 by the School of American Research, Santa Fe, New Mexico and in December 1976 and January 1977 by the University of New Mexico Office of Contract Archeology, Albuquerque. The surveys covered all land surface which may be disturbed by proposed mining activities for the remaining life of the mine.

The final report of the survey conducted by the School of American Research and preliminary reports of the surveys conducted by the University of New Mexico are included in Appendix B. These reports detail the method employed in the surveys, present maps showing locations of the areas surveyed and the sites discovered, describe the sites and their significance, and make recommendations for clearance, avoidance or mitigation. All reports have been submitted to Mr. William C. Allan, Archeologist, Bureau of Indian Affairs, Albuquerque, New Mexico.

APPENDIX XIII

Reclamation Information

irrigation supply. As a result, the vast majority of revegetation at the mine will rely on natural precipitation in the area, the distribution of which is fairly dependable.

5.4.2 Reclamation Equipment

Reclamation equipment that will be used at the Jackpile-Paguate mine appears in Table 5.4-1 with its projected use, status and cost. Not all pieces of equipment will be in use at one time and some equipment can be substituted for a particular reclamation use. For example, crawler-type tractors can pull the discing equipment for lime and mulch mixing and also can pull the seeding drill in place of the tractor. The larger crawler-type tractor can be substituted for the smaller crawler-type tractors for grading inslopes and diking around tops of waste dumps. Caterpillar scrapers will be utilized for transporting topsoils and favorable overburden to dump surfaces.

Cost of additional equipment for reclamation, i.e., tractor, disc, and drill will range from $28,000 to $51,000. The cost of 2 caterpillar scrapers will range from $400,000-$600,000. This additional equipment will insure that techniques requiring important timing in their application, such as mulching, seeding and fertilizing, will have equipment available solely for their execution.

TABLE 5.4-1

EQUIPMENT FOR RECLAMATION

Equipment	Use	Status	Cost
4-Crawler-type tractors, high horsepower class	Leveling free dump, mixing lime into surface, grading inslopes, backfilling pits, ripping crust on surface to aid in incorporating lime and mulch into surface material.	Available	Not Applicable
2-Crawler-type tractors low horsepower class	Mixing lime and mulch into surface, grading inslopes	Available	Not Applicable
3-Front-end loaders Dart 600 class	Loading ore stockpiles for transport to mill. Loading upper overburden for deposition on select waste dumps, and open pits. Loading topsoil for possible future use as surface material on critical growth areas after mine shutdown.	Available	Not Applicable
17-50 ton trucks	Transport of favorable overburden or topsoil to select surface areas.	Available	Not Applicable
1-Tractor with drawbar horsepower >65 hp	Spreading lime and mulch onto surface material, seeding and fertilizing.	Must Acquire	\$12,000-\$25,000
1-Discing rig for 6"-9" depth	Mixing lime and mulch into surface material	Must Acquire	\$ 8,000-\$14,000
1-Rangeland type drill with large seed, small seed & trashy seed box attachments & fertilizer attachments	Seeding	Must Acquire	\$ 8,000-\$12,000
2-Caterpillar scrapers model 660 B	Transporting topsoils and favorable overburden to dump surfaces.	Must Acquire	\$400,000-\$600,000

Tractors and discing equipment can be obtained from any commercial dealer.

The Rangeland Drill is a specialized piece of equipment and is not manufactured in commercial quantities. They can be made to specifications by the companies listed below:

Laird Welding and Manufacturing Works
Post Office Box 1053
Mercede, California 95340
Phone - (209) 722-4145

Otto M. Eash
Metal Masters
3862 Depot Road
Hayward, California 94545
Phone - (415) 352-1230

Lester G. Gaspar
Industrial Agricultural Services
International, Inc.
Post Office Box 1605
San Angelo, Texas 76901
Phone - (915) 944-1312

Work is currently being done to adapt a trashy seed box to the Rangeland Drill. Some plant species adapted to the environment of the Jackpile-Paguate mine have trashy seed, such as the grama grasses and galleta grass. The trashy seed box attachment should be included in specifications when ordering this piece of equipment.

The operation of the Rangeland Drill is a very important part of the success or failure of any seeding job. Since seeding is the heart of Anaconda's stabilization program, it is essential that actual seeding operations be done properly by a well-trained operator. The operation, maintenance and calibration of the drill must be checked to prevent malfunctions which can result in no seed being applied, uneven distribution of seed or too much seed being applied. Depth of planting must also be carefully controlled. The speed of operation is very important since moving too fast will result in bouncing of the drill, uneven distribution and poor coverage.

5.4.3 Specific Reclamation Techniques

Techniques for the various reclamation treatments are presented in Tables 5.4-2 to 5.4-4. Time of application is not included in the technique description except for seeding and fertilizing procedures. Furthermore, recommended amounts of lime, mulch, seed, and fertilizer are not absolute figures but are presented as ranges in Table 5.4-2. The techniques thus allow for schedule readjustment which can occur from mining schedule changes, changes in lime, mulch, seed, and fertilizer availability, and unfavorable weather conditions.

TABLE 5.4-2

RECLAMATION TECHNIQUES

Operation	Technique
Overburden deposition	Material in upper formation (Tres Hermanos) will be used to cap waste dumps and backfill areas which have been identified as having severe growth restrictions. Sufficient material will be applied to cover undesirable surface soil to a suitable depth. The central Paguate Pit will be graded and dressed to floodplain level. "Rabbit Ears" Pit will be backfilled.
Grading inslopes & diking	Surface configuration of waste dumps and backfill areas will be adjusted to 1-3 percent inslope to adjacent higher land surfaces. Dikes, approximately 1-2 feet high will circumscribe select capped off portions of waste dumps and select backfill areas.
Liming	Surface material will be sampled for acidity prior to any liming. Lime recommendations will follow the results of field testing. Table 5.4-3 shows relative magnitudes of lime requirements for various soils data.
Seeding	Several native seed mixtures will be applied to the surface. Native seed adapted to the local environment will be used. Species of seed and amount of each species to plant will depend on market availability at the time of requisition. 15 to 20 lbs/acre or more of total seed is recommended. Table 5.4-4 lists the seed characteristics for plant species adapted to the area. Seeding will be done during July 15 through August 15 of each year.
Mulching	One to two tons/acre hay or straw mulch will be applied and crimped into the surface.
Fertilizer	20 to 40 lbs/acre N and 20 to 30 lbs/acre P_2O_5 will be applied concurrent with seeding.

TABLE 5.4-3

GROUND LIMESTONE (TONS/ACRE) REQUIRED TO RAISE SOIL PH TO 7.0[a,b]

SOIL pH	Sands w/2.5% OM[c]	Sandy Loams w/3% OM	Loams and Silt loams w/4% OM	Silty Clay Loams w/5% OM
4.5	1.9	4.8	7.2	>10.0
5.0	1.6	4.0	6.1	8.4
5.5	1.0	2.2	3.2	5.1
6.5	0.4	1.2	1.8	2.2
7.0	0.2	0.6	0.8	1.0

[a] Modified from a figure appearing in Brady, N.C., 1974. The Nature and Properties of Soils. 8th Edition. MacMillan Publishing Co., Inc., New York. The original figure in Brady's book was taken from Peech, M., 1961. Lime Requirements vs. Soil pH Curves for Soils of New York State, mimeographed (Ithica, NY: Agronomy, Cornell University.

[b] Applications of lime at the Jackpile mine may need adjustment from those in the figure, to allow for low organic matter content and extreme soil acidity.

[c] Organic matter.

TABLE 5.4-4

SEED CHARACTERISTICS OF PLANT SPECIES ADAPTED TO THE CLIMATE AT THE JACKPILE-PAGUATE MINE

Plant Species	Recommended Variety	Availability	Site Adaptation	Seeds/lb.	Average Purity %	Germination %	Application Rate For One Species lb/Acre
Indian ricegrass *Oryzopsis hymenoides*	Native	Short supply or unavailable	Sandy to loam soils	235,000	95	11	11.0
Thickspike wheatgrass *Agropyron dasystachyum*	Critana	Available	Sandy to loam soils	186,000	95	91	14.0
Black grama *Bouteloua eriopida*	Nogal	Short supply or unavailable	Sandy to loam soils	1,335,000	40	60	2.0
Blue grama *Bouteloua gracilis*	Lovington	Available	Sandy to loam soils	712,000	40	60	3.5
Galleta *Hilaria jamesii*	Native	Available	Sandy to clay soils	159,000	69	80	16.0
Plains bristlegrass *Setaria macrostachya*	Native	Short supply or unavailable	Sandy soil	293,000	unavailable	unavailable	8.0
Sand dropseed *Sporobolus cryptandrus*	Native	Available	Sandy to loam soils	5,298,000	90	70	0.5
Sideoats grama *Bouteloua curtipendula*	Native	Available	Sandy to loam soils	143,000	60	50	18.0
Weeping lovegrass *Eragrostis curvula*	Native	Available	Sandy to loam soils	1,463,000	90	90	1.5
Yellow bluestem *Botriochloa ischaemum*	Native	Short supply or unavailable	Sandy to loam soils	1,409,000	60	70	2.0
Fourwing saltbush (Chamiza) *Atriplex canescens*	Native	Available	Sandy to clay soils	30,000	80	50	5.0**
Winterfat *Eurotia lanata*	Native	Short supply or unavailable	Sandy to loam soils	150,000	52	80	5.0**
Apache plume *Fallugia paradoxa*	Native	Short supply or unavailable	Sandy to loam soils	unavailable	unavailable	unavailable	9.0

TABLE 5.4-4 (Cont'd)

Plant Species	Recommended Variety	Availability	Site Adaptation	Seeds/lb.	Average Purity %	Germination %	Application Rate For One Species lb/Acre
Reed canarygrass <u>Phalaris</u> <u>arundinacea</u>	Ioreed	Available	Wet sites Sandy to loam soils	550,000	98	64	5.0
Tall wheatgrass <u>Agropyron</u> <u>elongatum</u>	Jose	Available	Wet sites Loamy to clay soils	790,000	95	85	32.0
Alkali sacaton <u>Sporobolus</u> <u>airoides</u>	Native	Short supply or unavailable	Wet sites Loamy to clay soils	1,750,000	98	80	1.5
Tobosa <u>Hilaria</u> <u>mutica</u>	Native	Short supply or unavailable	Wet sites Loamy to clay soils	204,000	8	42	13.0
Vine mesquite <u>Panicum</u> <u>obtusum</u>	Native	Short supply or unavailable	Wet sites Sandy to clay soils	143,000	50	36	18.0

Source: New Mexico Interagency Range Committee, 1973
** Recommended by Dames & Moore

STABILIZATION ALTERNATIVES: 1976-1981**

LAND SURFACE FEATURE	ALTERNATIVES	TECHNIQUES	SCHEDULE	ACRES	COST/ACRE (Dollars)	TOTAL COST* (Dollars)
Waste dump F	1. Topdress with material from on-going stripping operations. Prepare surface, lime if necessary, seed, mulch and fertilize.	Grade at 1% to 3% inslope to waste dump E. Measure pH with field test kit. If 6.0 apply fine grade limestone and work into surface 6 inches to 12 inches of soil. Check pH periodically and apply additional lime if necessary.	Overburden removal 1976, 1977. Lime 1977,1978.	85	2,672	227,120
	2. Grade rip surface, and lime.	Grade and lime similar to techniques above.	Grade 1976, 1977. Lime 1977, 1978.	85	128	10,880
Waste dumps C, D, E, H, I, X, U, S	1. Rip surface, lime if necessary	Same liming techniques as for waste dump F	Lime 1976, 1977, 1978	255, allowing for ≈ 55 acres established with desirable perennial vegetation and ≈ 19 acres of waste dump S included as future pits.	104	26,520
	2. Rip surface, lime if necessary. If desirable perennial vegetation is not establishing in three years, mulch, seed and fertilize.	Same liming techniques as for waste dump F. Apply 2 tons/acre straw or hay mulch. Disk into surface 6 inches to 12 inches of soil. Apply ~20 lbs/acre seed and cover with 1/4" to 1/2" of topsoil. Apply 40 lbs/acre N and 35 lbs/acre P_2O_5 concurrent with seedling establishment.	Lime as above. Mulch, seed and fertilize July 15-Aug 15 in 1979, 1980, 1981	255 allowing for ≈ 55 acres established with desirable perennial vegetation and ≈ 19 acres of waste dump S included in open pit.	419	106,845

*These are estimated costs and are intended only to present differences in magnitude for various alternatives. Furthermore, they may need adjusting for future economic trends.

**Waste dumps N, Z, W (62 acres) included in open pit stabilization acreage; acreages are given to the nearest estimated acre, and are not rounded off to the nearest 10 acres as in the reclamation plan text.

LAND SURFACE FEATURE	ALTERNATIVES	TECHNIQUES	SCHEDULE	ACRES	COST/ACRE (Dollars)	TOTAL COST (Dollars)
Waste dumps A, B, P, P_1, P_2, O	1. Rip surface, lime if necessary	Same liming technique as for waste dump F.	Lime 1976, 1977, 1978	96 allowing for ≈ 9 acres of P_1 and P_2 included in open pits.	104	9,984
	2. Rip surface, lime if necessary. Seed and fertilize	Same liming techniques as for waste dump F. Same seeding and fertilizing techniques as above	Lime 1976, 1977, 1978. Seed and fertilize July 15-Aug 15, 1979, 1980, 1981	96 allowing for ≈ 9 acres of P_1 and P_2 included in open pits.	219	21,024
Waste dumps G, V, Y, Y_1, J	1. Rip surface, lime if necessary	Same liming techniques as for waste dump F.	1978, 1979, 1980	117 allowing for ≈ 10 acres of V included in open pit.	104	12,168
	2. Rip surface, lime if necessary, plus mulch and seed	Same liming techniques as for waste dump F. Same mulching and seeding techniques as for waste dumps S, D, E, H, C, I, X, U, A, B, P, O	1978, 1979, 1980, 1981	117 allowing for ≈ 10 acres of V included in open pit.	384	44,928
Open pits	1. Topdress and grade ≈85 acres of N. Paguate pit to floodplain level, topdress remaining Paguate Pit and Jackpile pit with materials from ongoing stripping operations. Rip surface, lime if necessary, mulch, seed, fertilize	Same liming, mulching and seeding techniques as for other dumps	1979, 1980, 1981	200	2,702	540,400

*These are estimated costs and are intended only to present differences in magnitude [illegible] alternatives. Furthermore, they may need adjusting for future economic

STABILIZATION ALTERNATIVES: 1982-1985

LAND SURFACE FEATURE	ALTERNATIVES	TECHNIQUES	SCHEDULE	ACRES	COST/ ACRE	TOTAL* COST
Waste dumps K, M, L, T, R, Q and north and south dumps	1. Rip surface, lime if necessary, mulch, seed and fertilize.	Same techniques as for waste dumps C, D, E, H, I, X, U, S, A, B, P, O	Lime 1982, 1983, 1984. Mulch, seed, and fertilize July 15-August 15, 1982, 1983, 1984.	516	419	216,204
Open pits	1. Topdress pit areas with materials from final stripping operations, rip surface, lime if necessary, mulch, seed and fertilize.	Same as above.	Same as above.	1,057	2,678	2,830,646
Storage areas other than stockpiles	1. Rip surface, lime if necessary, mulch, seed and fertilize.	1. Same techniques as for waste dumps.	1985	70, allowing for ≈60 acres occupied by buildings	419	29,330
Open pits	1. Fence off pit walls and waterholes. Insure access to and from pit areas. Rip, lime, mulch, seed and fertilize accessible areas.	1. Use chain link fence for fencing. Same techniques as for waste dumps.	1985	79,200 linear feet of fence	3.20	253,440
Area cleared of stockpiles	1. Rip surface, lime, if necessary, mulch, seed and fertilize.	1. Same techniques as for waste dumps	1985	130, allowing for 39 acres in waste dumps and 45 acres in open pits.	419	54,470

*These are estimated costs and are intended only to present differences in magnitude for various alternatives. Furthermore, they may need adjusting for future economic trends.

STABILIZATION ALTERNATIVES:* AFTER 1985

LAND SURFACE FEATURE	ALTERNATIVES	TECHNIQUES	SCHEDULE	ACRES	COST/ACRE	TOTAL COST*
Roads	1. Rip surface, lime, if necessary, mulch, sand and fertilize.	1. Same techniques as for waste dumps	1985	141, allowing for ≈ 130 acres to remain as roads	419	59,079

*These are estimated costs and are intended only to present differences in magnitude for various alternatives. Furthermore, they may need adjusting for future economic trends.